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The MEDICAL DEPARTMENT OF THE UNITED STATES ARMY IN THE WORLD WAR

VOLUME IX

COMMUNICABLE AND OTHER DISEASES

PREPARED UNDER THE DIRECTION OF
MAJ. GEN. M. W. IRELAND
The Surgeon General

BY

LIEUT. COL. JOSEPH F. SILER, M. C., U. S. ARMY

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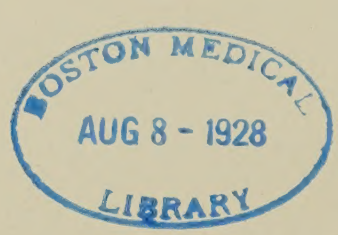

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LETTER OF TRANSMISSION

I have the honor to submit herewith Volume IX of the history of THE MEDICAL DEPARTMENT OF THE UNITED STATES ARMY IN THE WORLD WAR. The volume submitted is entitled "COMMUNICABLE AND OTHER DISEASES."

M. W. IRELAND,
Major General, the Surgeon General.

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[a] The highest rank held during the World War has been used in the case of each officer.

PREFACE [a]

The subject matter of this volume, which, for the most part, comprises the more important communicable diseases that concerned the Army and particularly the Medical Department during the World War, is arranged so as to consider, first, a statistical analysis and then the usual aspects of each of the diseases (diagnosis, treatment, etc.). In so far as the statistical analysis is concerned, a dichotomous table for each disease, or group of diseases comprising a chapter, forms a basis for subsidiary tables where these have been thought desirable. The basic tables show, for purposes of analysis, strength, and admissions, deaths, and noneffectiveness, not only in absolute numbers but also in rates per 1,000 strength. In addition, the incidence of the diseases considered is given geographically and by race. Where it is desirable, additional tables show urban and rural distribution; local prevalence, as in a large command or at a particular station; comparative incidence of certain diseases in the United States Army and in foreign armies.

As explained in Part Two of Volume XV of this history, the number of admissions does not represent the total case incidence. This is due to the fact that, in finally compiling all data on the sick and wounded cards in the Surgeon General's Office, it did not prove practical to record among the admissions all diseases coexisting at time of admission, or diseases occurring as complications while a case was on sick report. Instead, coexisting and complicating diseases were tabulated separately. Since the basic tables of the chapters of this volume, of necessity, comprise primary admissions only, they must be viewed in the light of the above explanation. In conjunction with them, however, additional tables show the number of cases recorded, among enlisted men in the United States and Europe, as concurrent diseases, complications and sequelæ, thus approximating the total number of cases.

Every effort was made in the Surgeon General's Office, in compiling vital statistics, to charge to original cases the places and times of occurrence, all discharges for disability, time lost, and deaths. This was done to facilitate computing case fatality, percentage of cases discharged for disability, and the amount of time lost for each character of case. Thus is explained attributing to such a disease as measles, for example, deaths which were in fact due to complicating bronchopneumonia.

Chapter XXII, concerning decisions as to the line of duty of disabilities, originally was intended for another volume of this history. Though it does not in any sense consider a disease, or a group of diseases, solely from the professional viewpoint, nevertheless it concerns diseases principally and thus more appropriately forms a part of this volume.

[a] For the purpose of the History of the Medical Department of the United States Army in the World War, the period of war activities extends from April 6, 1917, to December 31, 1919. In the professional volumes, however, in which are recorded the medical and surgical aspects of the conflict as applied to the actual care of the sick and wounded, this period is extended, in some instances, to the time of the completion of the history of the given service. In this way only can the results be followed to their logical conclusion.

TABLE OF CONTENTS

		Page
PREFACE		5
CHAPTER I.	Typhoid and the paratyphoid fevers. By Lieut. Col. Joseph F. Siler, M. C., and Maj. John S. Lambie, jr., M. C	15
II.	Inflammatory diseases of the respiratory tract (bronchitis; influenza; bronchopneumonia; lobar pneumonia). By Maj. Milton W. Hall, M. C	61
III.	Tuberculosis. By Col. George E. Bushnell, M. C	171
IV.	Cerebrospinal meningitis. By Maj. James S. Simmons, M. C., and Maj. Henry C. Michie, M. C	203
V.	Anthrax. By Maj. Henry C. Michie, M. C	223
VI.	Diphtheria. By Maj. John W. Meehan, M. C., and Maj. Henry C. Michie, M. C	233
VII.	The venereal diseases. By Maj. Henry C. Michie, M. C	263
VIII.	The diarrheal group of diseases. By Maj. Milton W. Hall, M. C., and Maj. Henry C. Michie, M. C	311
IX.	Smallpox. By Lieut. Col. Joseph F. Siler, M. C., and Maj. Henry C. Michie, M. C	357
X.	Chicken-pox. By Maj. Henry C. Michie, M. C	387
XI.	Scarlet fever. By Maj. Henry C. Michie, M. C	391
XII.	Measles. By Maj. Henry C. Michie, M. C., and Maj. George E. Lull, M. C	409
XIII.	Mumps. By Maj. Henry C. Michie, M. C	451
XIV.	German measles. By Maj. Henry C. Michie, M. C	463
XV.	Encephalitis lethargica. By Maj. Henry C. Michie, M. C	473
XVI.	Infectious jaundice; typhus fever; trench fever. By Maj. Arthur N. Tasker, M. C	483
XVII.	Vincent's disease. By Maj. Henry C. Michie, M. C	493
XVIII.	The malarial fevers. By Lieut. Col. Charles F. Craig, M. C	511
XIX.	Intestinal parasites. By Maj. Charles A. Kofoid, S. C	529
XX.	Diseases of the skin. By Maj. Arthur N. Tasker, M. C	551
XXI.	Neurocirculatory asthenia. By Col. Harlow Brooks, M. C	559
XXII.	Decisions as to whether or not disabilities were in line of duty. By Col. Weston P. Chamberlain, M. C	587
INDEX		611

LIST OF TABLES

Table		
1.	Typhoid fever. United States Army by war periods; also the British Army (South African War), showing admissions and deaths. Absolute numbers, rates per 1,000 per annum, and case mortality rates	17
2.	Typhoid fever. Deaths by years, 1890 to 1919, white enlisted men, United States Army, and estimated rates for male civilian population, ages 20 to 34. Annual rates per 1,000	20
3.	Typhoid fever and typhoid vaccination. Admissions, deaths, discharges for disability, and days lost from duty, officers and enlisted men (white, colored, and native troops) United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000	23
4.	Typhoid fever. By country of occurrence, showing percentage relationship to total admissions and deaths from disease, and relative standing among the 30 most common causes of admissions and deaths, April 1, 1917, to December 31, 1919	25

Table Page

5. Typhoid fever, Schofield Barracks, Hawaii. Vaccinated and unvaccinated groups, population, admissions, and deaths. Absolute numbers with rates per 1,000 and case fatality ---- 28
6. Typhoid fever. Admissions, enlisted men, by camps, September 1, 1917, to December 31, 1918. Absolute numbers and rates per 1,000 ---- 35
7. Typhoid fever. By years of occurrence, in the armies of seven of the important nations involved in the World War, showing number of cases and deaths with ratios per 1,000 per annum, and case fatality rates, 1914 to 1919 ---- 38
8. Typhoid fever. Concurrent with other diseases, enlisted men, United States Army, serving in the United States and Europe, April 1, 1917, to December 31, 1919 ---- 52
9. Paratyphoid fevers. Officers and enlisted men, April 1, 1917, to December 31, 1919, by country of occurrence, admissions, and deaths. Absolute numbers and rates per 1,000 ---- 58
10. Respiratory diseases. Primary admissions, officers and enlisted men, United States Army, by countries, April 1, 1917, to December 31, 1919. Absolute numbers, and annual ratios per 1,000 ---- 66
11. Respiratory diseases. Deaths, officers and enlisted men, United States Army, by countries, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 ---- 69
12. Respiratory diseases. Officers and enlisted men, United States Army, by countries, April 1, 1917, to December 31, 1919. Case fatalities and ratios of broncho-pneumonia to lobar pneumonia ---- 70
13. Total respiratory diseases (influenza, bronchitis, bronchopneumonia, and lobar pneumonia), white and colored enlisted men, United States Army, in the United States, by months, from April 1, 1917, to December 31, 1919 ---- 78
14. Total respiratory diseases (influenza, bronchitis, bronchopneumonia, and lobar pneumonia), white and colored enlisted men, United States Army in Europe, by months, from June, 1917, to December 31, 1919 ---- 78
15. Annual admission rates per 1,000 strength, white enlisted men, in the United States, by months, from April 1, 1917, to December 31, 1919 ---- 79
16. Annual death rates per 1,000 strength, white enlisted men, in the United States, from April 1, 1917, to December 31, 1919 ---- 79
17. Annual admission rates per 1,000 strength, colored enlisted men, in the United States, from April 1, 1917, to December 31, 1919 ---- 80
18. Annual death rates per 1,000 strength, colored enlisted men in the United States, from April 1, 1917, to December 31, 1919 ---- 80
19. Annual admission rates per 1,000 strength, white enlisted men in Europe, from June, 1917, to December 31, 1919 ---- 81
20. Annual death rates per 1,000 strength, white enlisted men in Europe, from June, 1917, to December 31, 1919 ---- 81
21. Annual admission rates per 1,000 strength, colored enlisted men in Europe, from November, 1917, to September 30, 1919 ---- 82
22. Annual death rates per 1,000 strength, colored enlisted men in Europe, from November 1, 1917, to September 30, 1919 ---- 82
23. Incidence of influenza and of influenza-pneumonia by weeks, June 17, 1918, to December 29, 1919. Annual rates per 1,000 ---- 84
24. Relative admission and death rates, and case fatalities from the respiratory group of diseases for white enlisted men, United States Army, by State of birth ---- 98
25. Relative position of the States in respect of rates of natives for admissions, deaths, and case fatality from the respiratory group of diseases, white enlisted men, United States Army ---- 99
26. Relative admission and death rates and case fatality for the respiratory group of diseases for colored enlisted men by State of birth, April, 1917, to December, 1919 ---- 107

Table Page
27. Influenza and pneumonia. Admissions, deaths, and case fatality rates, for 40 large camps in the United States during the fall epidemic, 1918 138
28. Cerebrospinal meningitis. Primary admissions, and deaths shown by countries of occurrence for officers and enlisted men, United States Army, with ratios per 1,000 strength, April, 1917, to December 31, 1919 205
29. Cerebrospinal meningitis. Primary admissions, and deaths by months with annual ratios per 1,000 strength; white and colored enlisted men, United States Army in the United States and Europe, April, 1917, to December, 1919 208
30. Cerebrospinal meningitis. By camps of occurrence, showing primary admissions and deaths, with annual ratios per 1,000 strength, white and colored enlisted men, United States Army; also case fatality rates, April, 1917, to December, 1919 211
31. Anthrax. Admissions and deaths, by countries, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919 223
32. Anthrax. Admissions and deaths, by specified camps of occurrence, enlisted men, United States Army, April 1, 1917, to December 31, 1919 224
33. Diphtheria. Admissions, deaths, discharges for disability, and days lost, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and annual ratios per 1,000 233
34. Diphtheria. Admissions and deaths by months, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919 235
35. Diphtheria. Admissions and deaths, by camps of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and annual ratios per 1,000 240
36. Diphtheria carriers. Admissions, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and annual ratios per 1,000 251
37. Diphtheria carriers. Admissions, by months, white and colored enlisted men, United States and Europe, April 1, 1917, to December 31, 1919 253
38. Results of cultures for the detection of diphtheria bacilli among soldiers arriving at the port of Hoboken on transports, December, 1918, to May, 1919 254
39. Diphtheria carriers and clinical cases of diphtheria, relative occurrence, at Debarkation Hospital No. 3, New York, December, 1918, to May, 1919 254
40. Diphtheria carriers. Duration of carrier state, embarkation and debarkation hospitals, New York, showing absolute numbers and average periods of hospitalization by 10-day groupings 258
41. Venereal diseases (all). Primary admissions, deaths, discharges for disability, and noneffectiveness, officers and enlisted men, United States Army, by countries of occurrence, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 264
42. Defects found in drafted men. Venereal diseases (all) 265
43. Gonococcus infection. Primary admissions, deaths, discharges for disability, and noneffectiveness, officers and enlisted men, United States Army, by countries of occurrence, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 272
44. Complications, sequelæ and concurrent diseases, among primary admissions for gonococcus infections in the United States Army, April 1, 1917, to December 31, 1919 274
45. Syphilis. Primary admissions, deaths, discharges for disability, and noneffectiveness, officers and enlisted men, United States Army, by countries of occurrence, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 293
46. Primary admissions with complications, sequelæ and concurrent diseases reported of 12,843 cases of syphilis in the United States Army, April 1, 1917, to December 31, 1919 299

Table Page
47. Diarrheal diseases. Primary admissions, white enlisted men in the United States, April, 1917, to December, 1919. Annual rates per 1,000 by months 313
48. The diarrheal diseases (dysentery, acute and chronic, and diarrhea). Admissions and deaths, absolute numbers and ratios per 1,000 per annum, white enlisted men, United States Army, 1819 to 1919 315
49. Dysentery (all), diarrhea, and enterocolitis. Offficers and enlisted men, United States Army, by countries of occurrence. Primary admissions, deaths, discharges for disability, and noneffectiveness, absolute numbers and ratios per 1,000 per annum, April, 1917, to December, 1919 318
50. Diarrheal group of diseases. Comparative mortality in the United States Army during the World War, and the United States registration area, males, age 20–34, 1917–1919. Annual death rates per 1,000 323
51. Dysentery. Incidence by types, and annual ratios per 1,000 by months, white enlisted men, United States Army, in the United States, April, 1917, to December, 1919 329
52. Dysentery. Incidence by types, and annual ratios per 1,000 by months, white enlisted men, United States Army, in Europe, April, 1917, to December, 1919 .. 330
53. Dysentery (all types). Primary admissions, United States Army, 1917 to 1919, shown by etiological types. Total cases in the United States and Europe. Absolute numbers 331
54. Smallpox. Admissions and deaths, white enlisted men, United States Army, 1840 to 1919. Rates per 1,000 358
55. Smallpox. Admissions and deaths United States Army in the Civil War, Spanish American War and Philippine Insurrection, and the World War. Absolute numbers and ratios per 10,000 359
56. Smallpox. Admissions and deaths, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 362
57. Smallpox. Admissions by camps of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 364
58. Smallpox. Numbers of admissions and ratios per 1,000 enlisted men (white and colored), United States Army, by States and groups of States, and comparable ratios per 1,000 among the civilian population of these States and groups, April 1, 1917, to December 31, 1919 366
59. Chicken-pox. Admissions and days lost, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919 387
60. Scarlet fever. Admissions, deaths, discharges for disability, and days lost, by countries, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919 391
61. Scarlet fever. Admissions and deaths, white and colored enlisted men, United States Army, United States and Europe, by months, April 1, 1917, to December 31, 1919 394
62. Scarlet fever. Admissions and deaths, by camps of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919 397
63. Scarlet fever. Complications, sequelæ, and concurrent diseases, April 1, 1917, to December 31, 1919 403
64. Admissions and deaths from scarlet fever, concurrent with other diseases, enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919 404
65. Measles. Admissions, deaths, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919 413
66. Measles. Admissions and deaths, by camps of occurrence, white and colored enlisted men, in the United States, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 419

Table Page
67. Measles and population, United States registration area, all ages, by States of occurrence, showing estimated population, July 1, 1918. Admissions, and deaths. Absolute numbers and ratios per 1,000 424
68. Measles. Admissions, deaths, discharges for disability, and days lost, by race, enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 428
69. Measles. Admissions, deaths, and case fatality rates, white and colored enlisted men, United States Army, by sections of the United States, April 1, 1917, to December 31, 1919 428
70. Measles. Concurrent diseases and complications, enlisted men in the United States and Europe, April 1, 1917, to December 31, 1919 431
71. Measles with bronchopneumonia. Admissions, deaths, and discharges for disability, by length of service, white enlisted men in the United States, April 1, 1917, to December 31, 1919 435
72. Measles with lobar pneumonia. Admissions, deaths, and discharges for disability, by length of service, white enlisted men in the United States, April 1, 1917, to December 31, 1919 435
73. Mumps. Admissions, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919 451
74. Mumps. Admissions, by camps of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919 453
75. Mumps. Admissions, by months, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919 454
76. German measles. Admissions, deaths, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 463
77. German measles. Admissions and deaths, by camps of occurrence, white and colored enlisted men, United States Army, with ratios per 1,000 strength, and case fatality rates, April, 1917, to December, 1919 467
78. German measles. Admissions, by months, white and colored enlisted men, United States Army, United States and Europe, Absolute numbers and ratios per 1,000, April, 1917, to December, 1919 468
79. Comparative occurrence, measles, German measles, and scarlet fever, in a selected group of camps in the United States, 1917 and 1918. Ratios per 1,000 472
80. Vincent's disease. Admissions, deaths, discharges for disability, and days lost, white and colored enlisted men and native troops, United States Army, by countries of occurrence, April 1, 1917, to December 31, 1919. Absolute numbers 495
81. Malarial fevers. Admissions and deaths, enlisted men, United States Army, 1911 to 1920. Ratios per 1,000 511
82. Malarial fevers. Admissions, deaths, and discharges for disability, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers, ratios per 1,000, per cent of total diseases, and relative standings 512
83. Malarial fevers. Admissions deaths, discharges for disability and days lost, by race, enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 514
84. Malarial fevers. Admissions, deaths, discharges for disability, and days lost, by countries of occurrence, white enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 515
85. Malarial fevers. Large camps, United States. Admissions, deaths, and discharges for disability, white and colored enlisted men, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 516
86. Malarial fevers. Admissions, deaths, discharges for disability, by State of induction, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919 517

Table Page
87. Malarial fevers. Admissions by months, white and colored enlisted men, United States, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 520
88. Malarial fevers, secondary to other diseases. Enlisted men, United States and Europe, April 1, 1917, to December 31, 1919. Absolute numbers, ratios per 1,000, and percentage rates 525
89. Comparative results in detection of ova by direct smear and brine flotation-loop methods 532
90. Hookworm infection in States in the hookworm area 541
91. Hookworm infection in the Middle West—Mississippi Valley 541
92. Hookworm infection in the Northeastern States 542
93. Hookworm infection in the Pacific Slope States 542
94. Summary of infection by intestinal parasites in 2,300 overseas troops and 576 home service troops, United States Army 545
95. Infections by hookworm and *Hymenolepis nana* in men from Northern States 547
96. Infections by hookworm and *Hymenolepis nana* in men from Southern States 547
97. Diseases of the skin and cellular tissue. Primary admissions, officers and enlisted man, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers 551

LIST OF CHARTS

Chart
I. Typhoid and typhus fevers, white enlisted men, United States Army, admissions and deaths, 1820–1919 16
II. Typhoid fever, enlisted men, United States Army, in continental United States, excluding Alaska, admissions and deaths, by years, for the period 1897–1919. Annual rates per 1,000 18
III. Deaths, typhoid fever, for white enlisted men, and estimated rates for male civilians, ages 20–34, 1890–1919 19
IV. Typhoid fever. Positive, clinical, and suspect cases, American Expeditionary Forces, showing strength, cases reported, and rates per 100,000 of strength, by weeks 29
V. Comparative trends of mortality rates per 1,000 for pneumonia and influenza, United States registration area for deaths, 1911–1920 64
VI. Annual admission rates per 1,000 strength, white enlisted men in the United States for influenza, bronchitis, lobar pneumonia, and bronchopneumonia, by months, April, 1917, to December, 1919 71
VII. The relations between the annual admission rates per 1,000 strength, white enlisted men in the United States, of the combined influenza and bronchitis and the combined lobar pneumonia and bronchopneumonia, by months, April, 1917, to December, 1919 72
VIII. Annual admission and death rates per 1,000 strength, for white and colored enlisted men in the United States, total respiratory group of diseases, by months, April, 1917, to December, 1919 73
IX. Annual admission and death rates for white and colored enlisted men in Europe, total respiratory group of diseases, by months, June, 1917, to December, 1919 74
X. Annual admission and death rates per 1,000 strength for white enlisted men in the United States and in Europe, total respiratory group of diseases, by months, April, 1917, to December, 1919 75
XI. Annual admission and death rates per 1,000 strength for colored enlisted men in the United States and in Europe, total respiratory group of diseases, by months, April, 1917, to December, 1919 76
XII. Case fatality rates, total respiratory group of diseases for white enlisted men in the United States and in Europe, by months, April, 1917, to December, 1919 77

Chart — Page

XIII. Case fatality rates, total respiratory group of diseases, for colored enlisted men in the United States and in Europe, by months, July, 1917, to December, 1919 — 77

XIV. Incidence of influenza and influenzal pneumonia, by weeks, for certain camps in the United States, June 17 to December 29, 1918. Annual admission rates per 1,000 strength — 85

XV. Percentage of total deaths from influenzal pneumonia during the war period occurring in each of the specified groups of length of service — 92

XVI. The relative mortality rates per 1,000 strength from influenzal pneumonia during the war period in each of the specified groups of length of service — 92

XVII. The relative admission rates for the respiratory group of diseases for white enlisted men by State of birth — 100

XVIII. The relative death rates from the respiratory group of diseases for white enlisted men by State of birth — 100

XIX. Case fatality rates (per cent) of the respiratory group of diseases for white enlisted men, by State of birth — 101

XX. Relative admission and death rates and case fatalities for the respiratory group of diseases in the various groups of States, April, 1917, to December, 1919 — 106

XXI. Relative death rates from the respiratory group of diseases by groups of States for the war period with the figures given by Vaughan and Palmer for the early months of the mobilization — 107

XXII. Comparison of effects of the fall epidemic of influenza on camps of different size in the United States — 112

XXIII. A comparison of the variations in the annual admission rates for the total respiratory diseases, the case fatality of measles, and the percentage of measles cases developing pneumonia, white enlisted men in 36 large camps in the United States, October, 1917, to March, 1919 — 131

XXIV. The relation between the total respiratory diseases and the pneumonias, annual rates per 1,000 for the 24 large camps in the United States which showed a definite peak for these diseases in the 1918 spring epidemic — 134

XXV. Tuberculosis, by camps. Admissions, white enlisted men, United States, April, 1917, to December, 1919. Ratios per 1,000 — 183

XXVI. Admissions and deaths for cerebrospinal meningitis, United States Army, 1900 to 1920. Ratios per 1,000 strength — 204

XXVII. Cerebrospinal meningitis, comparative rates, white and colored enlisted men, United States, April, 1917, to December, 1919 — 207

XXVIII. Cerebrospinal meningitis and mobilization. Admissions and number of enlisted men mobilized, United States. Comparative trend by months, April, 1917, to December, 1919 — 210

XXIX. Cerebrospinal meningitis, by camps. Admissions, white enlisted men, United States, April, 1917, to December, 1919 — 212

XXX. Diphtheria. Comparative rates, white and colored enlisted men, United States, April, 1917, to December, 1919 — 239

XXXI. Diphtheria, by camps. Admissions, white enlisted men, United States, April, 1917, to December, 1919 — 241

XXXII. Diphtheria, by native States, white enlisted men, United States Army, United States and Europe, April, 1917, to December, 1919. Ratios per 1,000 — 242

XXXIII. Venereal diseases (all) and mobilization. Admissions and number of men mobilized, United States. Comparative trend by months, April, 1917, to December, 1919 — 266

XXXIV. Venereal diseases (all) and enlisted strength, white and colored troops, United States and Europe, comparative trend by months, April, 1917, to December, 1919 — 267

Chart — Page

XXXV. Venereal diseases (all) and enlisted strength, actual for white troops but both raised for colored troops, United States and Europe. Comparative trend by months, April, 1917, to December, 1919 — 268

XXXVI. The diarrheal group of diseases. Annual admission rates by months for dysentery (all), diarrhea, and enterocolitis, white enlisted men in the United States — 313

XXXVII. The diarrheal group of diseases. Admissions and deaths in the United States Army, 1819 to 1919. Annual rates per thousand — 316

XXXVIII. Dysentery, incidence by etiologic types by months, annual rates per 1,000, white enlisted men, United States Army, in the United States — 328

XXXIX. Dysentery. Comparative rates, white and colored enlisted men, United States, April, 1917, to December, 1919 — 333

XL. Dysentery. Comparative trend, enlisted men, United States Army, United States and Europe, admissions and deaths by months, April, 1917, to December, 1919 — 335

XLI. Smallpox, white enlisted men, United States Army, admissions and deaths, 1840–1919. Ratios per 1,000 — 359

XLII. Smallpox in the United States Army and civil population, April 1, 1917, to December 31, 1919. Occurrence by groups of States. Ratios per 1,000 population — 367

XLIII. Scarlet fever. By States of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919. Ratios per 1,000 — 398

XLIV. Measles. White enlisted men, United States Army, admissions and deaths, 1840–1919. Ratios per 1,000 — 410

XLV. Measles. Civil, Spanish American, and Philippine Insurrection, and World Wars, white and colored enlisted men, United States Army, by months. Ratios per 1,000 — 412

XLVI. Measles and mobilization. Admissions and number of enlisted men mobilized, United States. Comparative trend by months, April, 1917, to December, 1919 — 415

XLVII. Measles, by camps. Admissions, white enlisted men, United States, April, 1917, to December, 1919. Ratios per 1,000 — 416

XLVIII. Measles, by native States, white enlisted men, United States and Europe, United States Army, April, 1917, to December, 1919. Ratios per 1,000 — 418

XLIX. Measles. Comparative rates, white and colored enlisted men, United States, April, 1917, to December, 1919 — 420

L. Measles. Comparative trend, enlisted men, United States Army, United States and Europe. Admissions and deaths by months, April, 1917, to December, 1919 — 426

LI. German measles. Comparative trend, enlisted men, United States Army, United States and Europe. Admissions by months, April, 1917, to December, 1919 — 465

LII. Scabies. White and colored enlisted men, United States, by months. Rate per 1,000 — 554

LIII. Scabies. White and colored enlisted men in Europe, by months. Rate per 1,000 — 555

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CHAPTER I

TYPHOID AND THE PARATYPHOID FEVERS [a]

Typhoid and paratyphoid fevers were of but minor importance as causes of sickness in the United States Army during the World War. This negative condition, however, is of all the more present interest in view of the fact that in previous wars, as is shown below, our experience with typhoid fever was quite different. Prior to the World War enteric fever (typhoid) was one of the greatest scourges of armies mobilized for war. In the British Army in the South African War (1899–1901), approximately 59,750 cases of typhoid fever occurred (average annual strength, 209,404), with a case mortality rate in excess of 10 per cent (8,227 deaths.)[1] During the Spanish-American War (1898), with a mean annual strength of 147,795 men, there were reported 20,926 cases of typhoid fever in our Army, with 2,192 deaths.[2]

Prior to the development of the fairly simple laboratory technique (Widal reaction) for the identification of the *B. typhosus*, the diagnosis of typhoid fever was based on clinical manifestations. Consequently, the medical statistics of the Army prior to and even during the Spanish-American War, as well as all other statistical records for like periods, whatever their source, are not accurate in so far as typhoid fever is concerned. They are sufficiently reliable, however, to justify their use in reviewing, for comparative purposes, the prevailing trend of the disease. Since the Spanish-American War the Medical Department has devoted special attention to the prevention of typhoid fever, and the regulations for many years have provided that its diagnosis, for record purposes, must be based on the clinical picture, confirmed by laboratory findings. During the World War, when it became necessary to mobilize approximately 4,000,000 men within a relatively short period of time, it manifestly was impracticable to confirm all clinical diagnoses of typhoid and paratyphoid fevers by laboratory methods; but the laboratory and clinical investigations were quite searching, and the probability of error in recorded diagnoses was undoubtedly small; however, the recorded mortality rates during the World War are somewhat exaggerated. The explanation for this is that in tabulating causes of death during the World War, it was the practice in the Surgeon General's Office, to charge deaths to the primary cause of admission. Thus, individuals who were admitted to hospital for typhoid fever, and who developed influenzal pneumonia concurrently, during the pandemic of influenza, and who actually died of that complication, were recorded as having died of typhoid. Careful studies of a large series of cases occurring in the American Expeditionary Forces, demonstrate that the case mortality did not exceed 11 per cent,[3] whereas the basic statistical tables of the Surgeon General's Office, which are used in Volume XV of this history, indicate that it was approximately 13.7

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

per cent. Some mild cases of typhoid fever also were overlooked, having been confused with the intestinal type of influenza prevailing so generally during the late fall and early winter of 1918. The morbidity rates in the tables presented herein are slightly less, therefore, than the actual rate of occurrence of typhoid fever, and mortality rates are considerably in excess of the actual death rate.

As the subject matter herein deals principally with the limited occurrence of diseases of this group, rather than their fairly common occurrence, and with the facts underlying and accounting for such limitation, the material reviewed is analyzed principally from an epidemiological point of view.

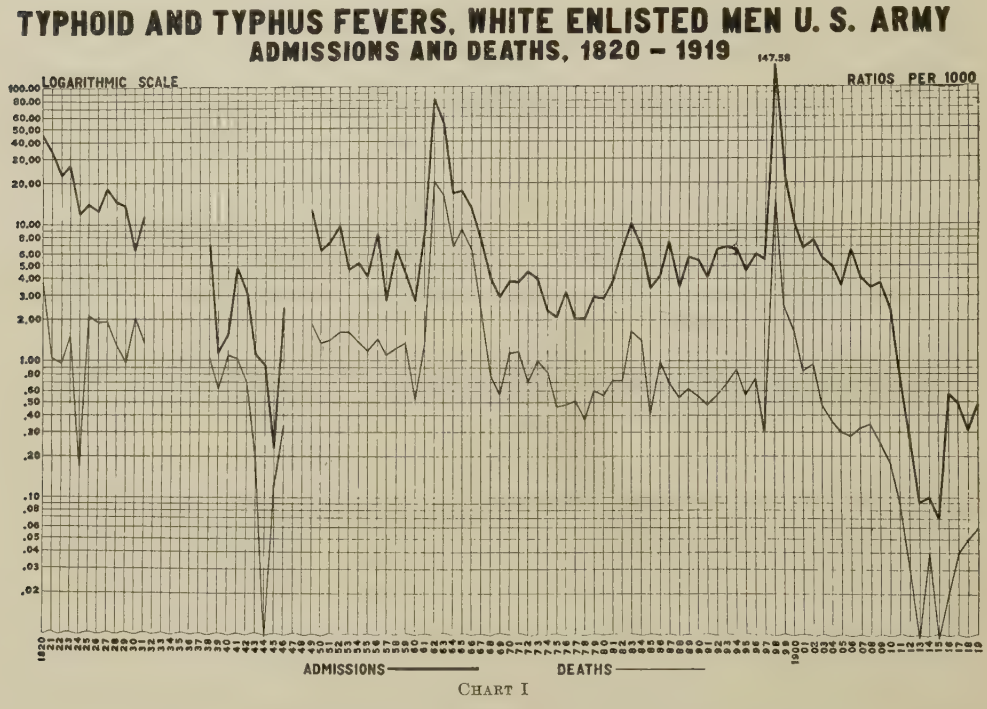

CHART I

TYPHOID FEVER IN THE UNITED STATES ARMY PRIOR TO THE WORLD WAR, AND AS COMPARED WITH WORLD WAR INCIDENCE

In so far as the earliest records of the American Army are concerned typhus fever was the disease with which typhoid fever was most frequently confused,[4] and it was not until 1851 that the nomenclature used by the Medical Department of the Army separated the two and accepted the diagnosis "febris typhoides." Furthermore, in the first few months of the Spanish-American War, Army surgeons failed clearly to separate typhoid fever and malaria, and it was only when the disease assumed the proportions of an epidemic that its character was understood.[5] It is quite evident, therefore, that, as stated above, the Army typhoid statistics prior to the Spanish-American War are not accurate and the grouping together of admissions and deaths from both typhoid and typhus fever will more nearly approximate the actual prevalence of typhoid fever in the Army. This method of presentation, therefore, has been adopted in discussing the prevalence of typhoid in the Army prior to the World War.

The trend of typhoid fever in the Army from 1820 to 1919, is plotted on logarithmic scale in Chart I.

Records are not available from 1832 to 1837, nor for a part of the period of the Mexican War (1846–1848). Prior to 1910 the admission rates, although irregular, were high, ranging—except for war periods—from 2 to 10 per 1,000 per annum, and the death rate ranged from about 0.30 to 1.50 during the same period.

The very low ratio recorded for 1844 is inexplicable, notwithstanding a careful search of War Department records. The mean strength of the Army during 1844 was about 8,500 men and the reported admissions for all diseases were less than for the year 1843. But few troops were on field duty during 1844, the Florida Indian War having come to an end during 1842.

Two striking and significant peaks of occurrence are shown in Chart I, the first marking the Civil War and the second the Spanish-American War. From an epidemiological and practical point of view the fact of greatest importance shown in the chart is the precipitate downward trend in typhoid admission rates which commenced in 1909. This reduction coincided with the introduction of typhoid vaccine in the Army, as a preventive measure, the value of which is more clearly visualized in Chart II.

As typhoid rates always increase markedly during war periods, it will be well to examine in greater detail, the rates in the Army during such periods. The admission and death rates for typhoid fever during the Civil, Spanish-American, and World Wars are shown in Table 1; comparable rates for the British Army during the South African War also are included for purposes of discussion.

TABLE 1.—*Typhoid fever. United States Army by war periods; also the British Army (South African War), showing admissions and deaths. Absolute numbers, rates per 1,000 per annum, and case mortality rates* [a]

War	Average annual strength	Admissions		Deaths		Case mortality rate (per cent)
		Absolute numbers	Rates per 1,000 per annum	Absolute numbers	Rates per 1,000 per annum	
Civil War (1861–1866)—All troops Northern Army	532,198	79,462	29.86	29,336	11.02	36.92
Spanish-American War (1898)—U. S. Army	147,795	20,926	141.59	2,192	14.83	10.47
South African War (1899–1901)—British Army (2.5 years)	209,404	59,750	114.13	8,227	15.72	13.77
World War (1917–1919)—U. S. Army (2.75 years)	1,501,265	1,529	.37	227	.05	14.85

[a] Source of information: (1) Medical and Surgical History of War of the Rebellion, Part I, Medical Volume. (2) Report of the Surgeon General of the Army, 1900, p. 402. (3) Official History of the War, Medical Services Diseases of the War, Vol. I, London, His Majesty's Stationery Office, 11. (4) Monthly sick and wounded reports, Office of the Surgeon General, 1917–1919.

The recorded morbidity rates for the Civil War do not give a true picture of the actual occurrence of the disease. Experience has taught that the case mortality rate for typhoid fever ordinarily is about 10 per cent. Calculation of the case mortality rate from the recorded morbidity and mortality for the Civil War gives a case fatality rate of 36.9 per cent which, manifestly is much too high. Reversing the process and calculating the morbidity rate from the

TYPHOID FEVER, ADMISSIONS AND DEATHS BY YEARS 1897-1919
ENLISTED MEN IN CONTINENTAL U.S., EXCLUDING ALASKA
ANNUAL RATES PER 1,000

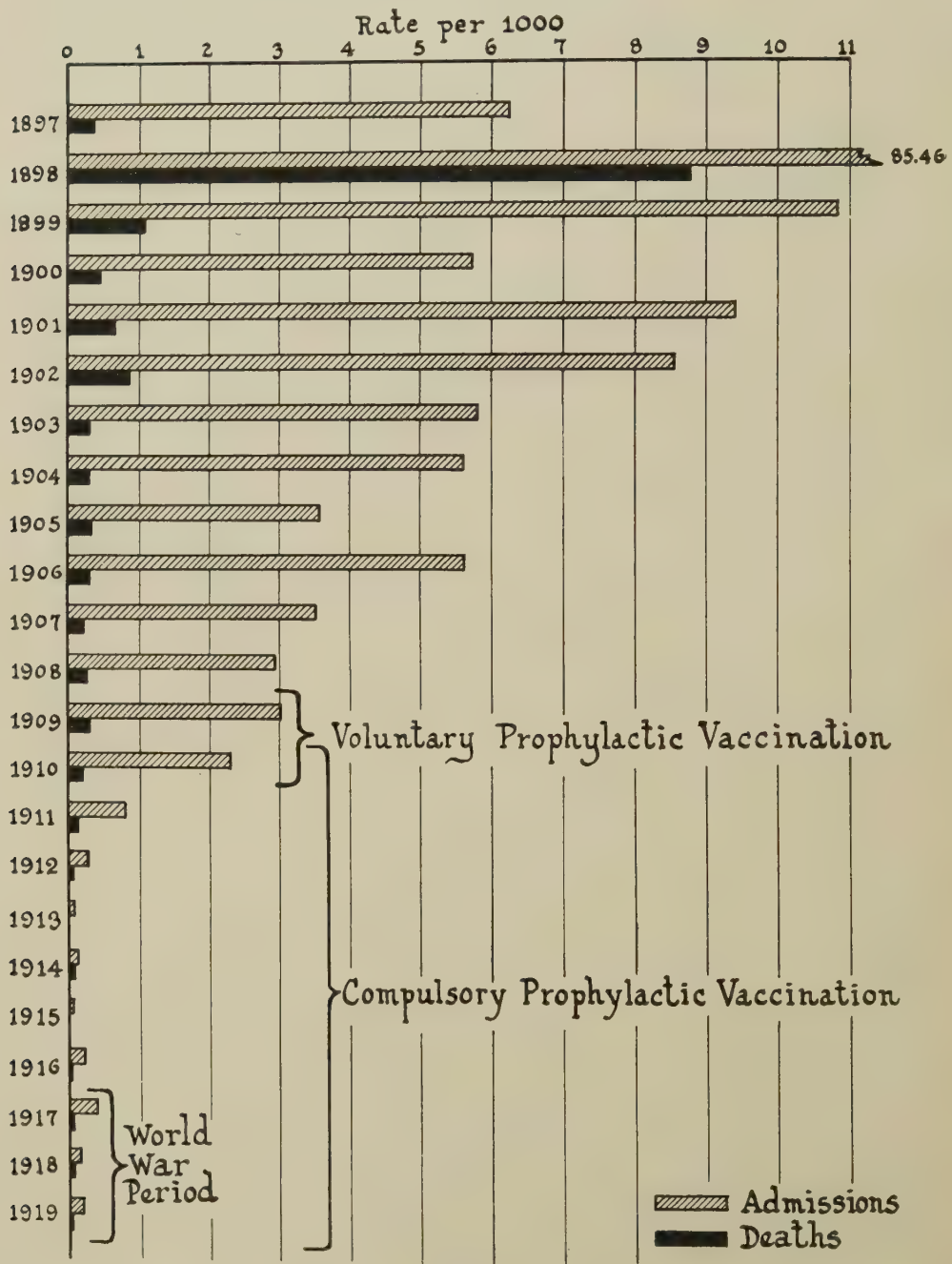

CHART II

recorded mortality statistics on the basis of a case fatality rate of 10 per cent, gives an admission rate for the Civil War period somewhat in excess of 100 rather than one of 30.5 per 1,000. This rate undoubtedly approximates more nearly the actual prevalence of the disease.

DEATHS, TYPHOID FEVER FOR WHITE ENLISTED MEN, AND ESTIMATED RATES FOR MALE CIVILIANS,* AGES 20 - 34, 1890 - 1919

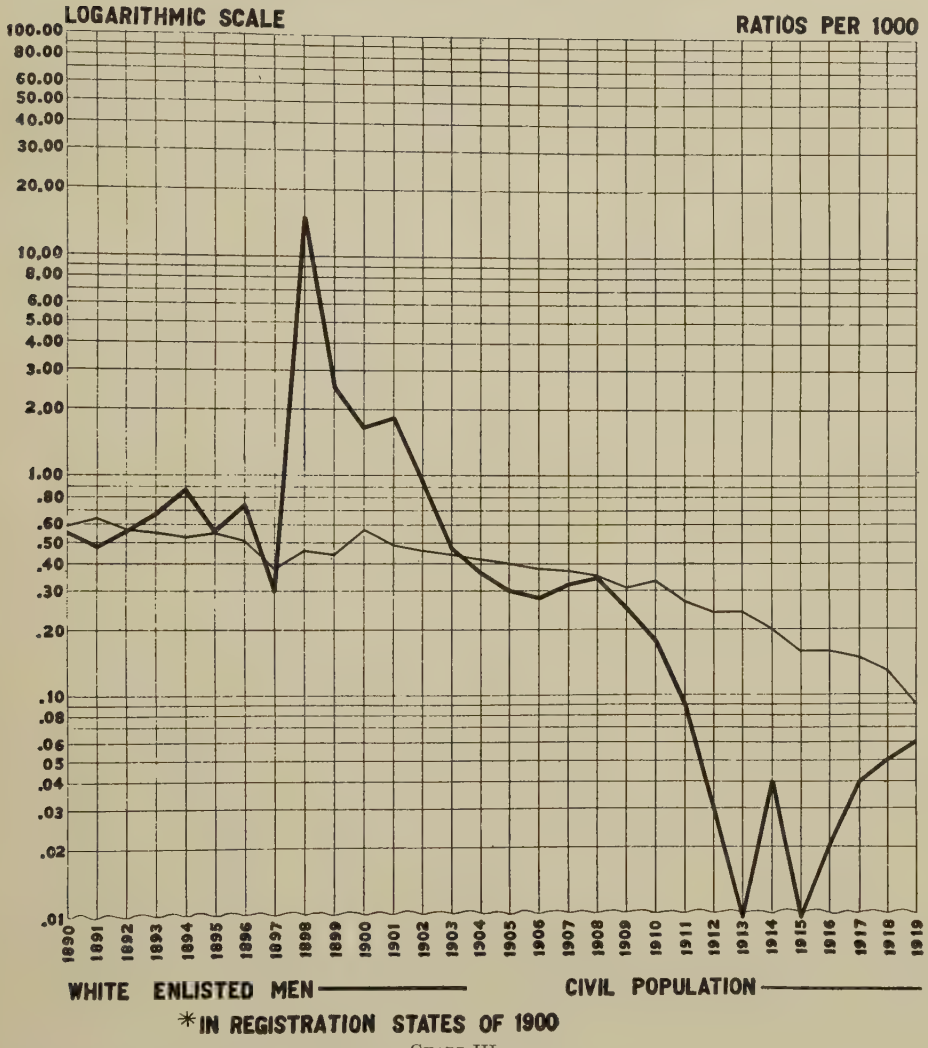

CHART III

The incidence rate of 141.59 per 1,000 per annum for the Spanish-American War (1898) doubtless is quite accurate, as the case mortality rate calculated from recorded morbidity and mortality is 10.47 per cent. The Spanish-American War was of short duration and the vast majority of the 20,000 or

more cases of typhoid fever occurred within a comparatively short period of time during the summer and fall of 1898.

The recorded morbidity rate for the British Army during the South African War probably is somewhat less than was the actual occurrence of the disease, as the case mortality rate, based on recorded morbidity and mortality, is somewhat higher (13.77 per cent) than that ordinarily to be anticipated.

The incidence rate of 0.37 per 1,000 per annum for American troops during the World War is in striking contrast with all previously recorded war-time rates and demonstrates in a very telling manner that epidemics of typhoid fever can be prevented in armies. The recorded case mortality rate for American troops during the World War was approximately 14.85 per cent, which is considerably in excess of the case death rate ordinarily to be anticipated. As explained above this high recorded death rate in all probability is due in large part to the fact that deaths were charged to typhoid fever that actually were due to influenzal pneumonia. A comprehensive special investigation of typhoid fever in the United States Army in France, made at the time the disease was prevailing, which is given fuller consideration below, demonstrated very clearly that the case death rate was not in excess of 11 per cent of the individuals attacked.[3]

COMPARISON OF DEATH RATES FOR TYPHOID FEVER IN THE UNITED STATES ARMY AND IN THE CIVIL POPULATION

From Table 2 it is possible to gain a definite conception of the comparative prevalence of typhoid in American civil communities and in the Army. The statistics incorporated in Table 2 are presented graphically in Chart III.

TABLE 2.—*Typhoid fever. Deaths by years, 1890 to 1919, white enlisted men, United States Army, and estimated rates for male civilian population, ages 20 to 34. Annual rates per 1,000*

Year	Death rates per 1,000 per annum		Year	Death rates per 1,000 per annum	
	White enlisted men	Male civilians, ages 20–34		White enlisted men	Male civilians, ages 20–34
1890	0.55	0.59	1905	0.30	0.40
1891	.48	.64	1906	.28	.38
1892	.56	.57	1907	.32	.37
1893	.67	.55	1908	.34	.35
1894	.87	.53	1909	.25	.31
1895	.56	.55	1910	.18	.33
1896	.74	.51	1911	.09	.27
1897	.30	.38	1912	.03	.24
1898	15.26	.46	1913		.24
1899	2.52	.44	1914	.04	.20
1900	1.67	.57	1915		.16
1901	.84	.49	1916	.02	.16
1902	.95	.46	1917	.04	.15
1903	.47	.44	1918	.05	.13
1904	.36	.42	1919	.06	.09

It may be noted that for the years 1900 to 1903, inclusive, the Army rate was considerably in excess of that for the registration area of the United States, with so marked a downward trend for the Army rates that the two differed but slightly for the last year of the four-year period. For the years 1904 to 1909, inclusive, the rates for the two groups were very nearly the same.

From 1910 onward, however, while the rate for the civil population had a very considerable downward trend, comparable rates for the Army were at an extraordinarily low level, and this decline took place within a period of three years (1910–1912). During the period, 1910 to 1919, the civil population was not subjected to any unusually adverse environmental conditions and the reduction of the mortality rate by more than one-half during the 10-year period can be attributed primarily to improvements in environmental sanitation plus an unknown but probably quite considerable amount of prophylactic vaccination during the later years of the period.

In so far as the Army is concerned, the high rates for the years 1900 to 1903 were due to conditions approximating those of war. It was during this period that considerable numbers of troops were operating in the Philippines. Profiting by the experience gained during the Spanish-American War (1898) and the immediately following Philippine insurrection, the Medical Department of the Army redoubled its efforts to prevent typhoid fever in Army personnel. No very noticeable reduction in rates was attained, however, until 1910. During 1910 and 1911 the rates were cut in half and in 1912 the reduction was so marked that the death rate was only one-tenth of that which prevailed prior to 1909. It was in the latter part of 1909 that prophylactic typhoid immunization was introduced in the Army as a voluntary measure,[6] and in 1911 it was made mandatory for all military personnel.[7]

The typhoid mortality rates for the civil population tabulated in Table 2 are crude rates, and when corrected for age and sex the results attained in the Army in the prevention of typhoid fever during the World War become more striking. With minor exceptions the military personnel in active service during the World War (1917–19) ranged between 20 and 34 years of age. The death rate from typhoid fever for males of the civilian population of that age group for the period averaged about 0.117 per 1,000 per annum, as compared with a rate of 0.05 per 1,000 per annum for military personnel.

OCCURRENCE OF TYPHOID FEVER IN THE ARMY DURING THE WORLD WAR

Armies are much more apt to become seeded with typhoid bacilli brought in by recruits from civil life during periods of hurried mobilization than during the more orderly and leisurely recruitment incident to times of peace. If, therefore, typhoid fever is of common occurrence in civilian communities it may be anticipated that it will gain a foothold and spread with great rapidity in armies during periods of mobilization, provided preventive measures are not effective.

When mobilization was ordered in 1917 typhoid fever prevailed to a much less degree throughout the United States than was the case at the beginning of the Spanish-American War. It was of very common occurrence in the civil population of our country in 1898, was introduced into all mobilization camps, and spread with great rapidity.[8]

During the 15 or 20 years preceding the World War there had been so marked and continuous a reduction in typhoid rates in the civil population throughout the United States that the likelihood of the wholesale introduction of the disease into our mobilization camps in 1917, by incoming recruits, was

somewhat remote. As a matter of fact, a total of only 546 cases of typhoid fever occurred among enlisted men in camps in the United States during the World War, and in a large proportion of these cases the disease was contracted prior to reporting at camps.

When we turn, however, to comparable conditions confronting our troops on the Western Front in France, the picture is a different one. The water supplies, as a rule, were not above suspicion of contamination, typhoid fever was of no uncommon occurrence in the civilian population, it was known to have occurred in troops occupying sectors in which most of our divisions operated,[9] large numbers of cases of typhoid fever occurred in the relatively unprotected British Expeditionary Force in France during the early stages of the war,[10] and the rates of incidence in the partially protected French armies for the first two years (1914–15) of the war were very high.[9] The possibility of acquiring the disease from outside sources in France therefore, was, almost unlimited, and had our preventive measures not been effective the disease undoubtedly would have prevailed quite extensively.

TOTAL NUMBER OF CASES

It is necessary to have clearly in mind that this discussion relates to the occurrence of typhoid fever in individuals who had been protected against the disease by prophylactic vaccines, in so far as it was possible to carry out this procedure efficiently during the stress of hurried mobilization. In a considerable number of instances the service records of individuals failed to bear notation that three doses of antityphoid-paratyphoid vaccine had been given; but investigation of the administrative procedures adopted in carrying out this protective measure and the safeguards instituted to prevent troops going overseas without such vaccinations, warrants the statement that but few individuals received less than three doses of the saline vaccine or one of the lipovaccine. Prior to July 1, 1918, it was the custom to administer three doses of saline vaccine and after that date either three doses of saline vaccine or one of lipovaccine.[11] All drafted men received protective vaccines immediately after reporting at mobilization camps.

Examination of Table 3 indicates that during the World War (April, 1917, to December, 1919) the aggregate of the mean annual strength of our military forces was 4,128,479; during the same period, 1,529 primary admissions for typhoid fever were reported, the typhoid rate per 1,000 of strength being 0.37. The progress made in the control of typhoid fever since the Spanish-American War can be visualized more clearly when it is realized that, whereas during the Spanish-American War the total typhoid rate was 141.59 per 1,000, during the World War it fell to 0.37 per 1,000, the relative proportions being approximately 382 to 1.

TABLE 3.—*Typhoid fever and typhoid vaccination—Admissions, deaths, discharges for disability, and days lost from duty, officers and enlisted men (white, colored, and native troops), United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 per annum*

	Total mean annual strengths	Typhoid fever							
		Admissions		Deaths		Discharges for disability		Days lost	
		Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Non-effective rates per 1,000
Total officers and enlisted men, including native troops	4,128,479	1,529	0.37	227	0.05	24	0.01	109,374	0.07
Total officers and enlisted men, American troops	4,092,457	1,527	.37	227	.06	24	.01	109,315	.07
Total officers	206,382	49	.24	77	.03			4,367	.06
Total enlisted American troops:									
White	3,599,527	1,348	.37	182	.05	24	.01	97,104	.07
Colored	286,548	68	.24	25	.09			3,904	.04
Color not stated		62		13				3,940	
Total	3,886,075	1,478	.38	220	.06	24	.01	104,948	.07
Total native troops enlisted	36,022	2	.06					59	.00
Total Army in the United States (including Alaska):									
Officers	124,266	18	.14	3	.02			1,132	.02
White enlisted	1,965,297	483	.25	54	.03	11	.01	25,020	.03
Colored enlisted	145,826	45	.31	17	.11			2,435	.05
Total enlisted	2,111,123	528	.25	71	.03	11	.01	27,455	.04
Total officers and men	2,235,389	546	.24	74	.03	11	.00	28,587	.04
United States Army in Europe, excluding Russia:									
Officers	73,728	27	.37	4	.05			2,844	.11
White enlisted	1,469,656	776	.53	123	.08	13	.01	68,407	.13
Colored enlisted	122,412	23	.19	8	.07			1,469	.03
Color not stated		59		13				3,929	
Total enlisted	1,592,068	858	.54	144	.09	13	.01	73,805	.13
Total officers and men	1,665,796	885	.53	148	.09	13	.01	76,649	.13
Officers, other countries	8,388	4	.48					391	.13
United States Army in Philippine Islands:									
White enlisted	16,995								
Colored enlisted	4,456								
Total enlisted	21,451								
United States Army in Hawaii:									
White enlisted	16,161	50	3.09	4	.25			3,305	.56
Colored enlisted	3,319								
Total enlisted	19,480	50	2.57	4	.21			3,305	.47
United States Army in Panama, white enlisted	19,688								
United States Army in other countries not stated:									
White enlisted		38						343	
Color not stated		3						11	
Total	14,232	41	2.88					354	.07
Transports:									
White enlisted	97,498	1	.01	1	.01			29	.00
Total enlisted	108,033	1	.01	1	.01			29	.00
Native troops enlisted:									
Philippine Scouts	18,576	1	.05					8	.00
Hawaiians	5,615								
Porto Ricans	11,831	1	.08					51	.01

TABLE 3.—*Typhoid fever and typhoid vaccination—Admissions, deaths, discharges for disability, and days lost from duty, officers and enlisted men (white, colored, and native troops), United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000 per annum*—Continued

	Typhoid vaccination					
	Admissions		Discharges for disability		Days lost	
	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000
Total officers and enlisted men, including native troops	35,552	8.61	5	0.00	156,548	0.10
Total officers and enlisted men, American troops	35,149	8.59	5	.00	155,614	.10
Total officers	593	2.87			2,325	.03
Total enlisted American troops:						
White	30,915	8.59	4	.00	129,713	.10
Colored	3,606	12.58	1	.00	23,277	.22
Color not stated	35				299	
Total	34,556	8.89	5	.00	153,289	.11
Total native troops enlisted	403	11.19			934	.07
Total Army in the United States (including Alaska):						
Officers	564	4.54			2,220	.05
White enlisted	30,080	15.30	4	.00	121,528	.17
Colored enlisted	3,562	24.42	1	.01	22,885	.43
Total enlisted	33,642	15.94	5	.00	144,413	.19
Total officers and men	34,206	15.30	5	.00	146,633	.18
United States Army in Europe, excluding Russia:						
Officers	14	.19			72	.00
White enlisted	363	.25			6,633	.01
Colored enlisted	11	.09			306	.01
Color not stated	34				298	
Total enlisted	408	.26			7,237	.01
Total officers and men	422	.25			7,309	.01
Officers, other countries	15	1.79			33	.01
United States Army in Philippine Islands:						
White enlisted	39	2.29			189	.03
Colored enlisted	12	2.69			19	.01
Total enlisted	51	2.38			208	.03
United States Army in Hawaii:						
White enlisted	230	14.23			656	.11
Colored enlisted	21	6.33			67	.06
Total enlisted	251	12.89			723	.10
United States Army in Panama, white enlisted	41	2.08			122	.02
United States Army in other countries not stated:						
White enlisted	10				95	
Color not stated	1				1	
Total	11	.77			96	.02
Transports:						
White enlisted	152	1.56			490	.01
Total enlisted	152	1.41			490	.01
Native troops enlisted:						
Philippine Scouts	86	4.63			275	.04
Hawaiians	17	3.03			91	.04
Porto Ricans	300	25.36			568	.13

RELATIVE IMPORTANCE OF TYPHOID FEVER AS A CAUSE OF ADMISSION TO HOSPITAL FOR DISEASE AND OF DEATHS FROM DISEASE

The fact that typhoid fever, comparatively speaking, was of minor importance as a cause of admission to hospital for disease during the World War is well shown in Table 4.

TABLE 4.—*Typhoid fever. By country of occurrence, showing percentage relationship to total admissions and deaths from disease, and relative standing among the 30 most common causes of admissions and deaths, April 1, 1917, to December 31, 1919*

	Admissions		Deaths	
	Percentage relationship to total diseases	Relative standing among 30 most common diseases	Percentage relationship to total diseases	Relative standing among 30 most common diseases
Officers:				
United States	0.02		0.35	22
Europe	.07		.71	11
Total officers (including other countries)	.04		.47	15
American enlisted men, United States	.02		.21	19
Europe	.10		.69	10
Hawaiian Islands	.42		10.26	2
Total enlisted (including other countries)	.04		.39	13
Native troops:				
Filipino	.01			
Porto Rican	.01			
Total native troops	.01			
Total, U. S. Army	.04		.39	13

Typhoid fever contributed only 0.04 per cent of the total admissions to hospital for all diseases, and in no country in which our military forces served did it prevail to such degree as to give it a rating in the list of the 30 diseases of most frequent occurrence. Of all deaths from disease during the World War only 0.39 per cent were attributable to typhoid fever, and in the list of the 30 diseases most frequently resulting in death, in order of importance (1 to 30), it occupied the thirteenth place.

DISTRIBUTION BY GRADE (COMMISSIONED AND ENLISTED PERSONNEL)

The admission rate for commissioned personnel was appreciably lower than for enlisted—officers, 0.24, and American enlisted, 0.38 per 1,000. This is explicable on the basis of better education, higher degree of intelligence, a more comprehensive knowledge of personal hygiene and sanitation and their corollaries, more intelligent compliance with instructions and orders, and better personal hygienic and environmental sanitation.

RACIAL DISTRIBUTION

The morbidity rate for white enlisted personnel was considerably higher than for colored—white American, 0.37; colored American, 0.24 per 1,000. The most probable explanation of the higher rate in white American troops is that it was due to the fact that a relatively larger proportion of white troops were engaged in operations in highly contaminated areas (combat areas), with a correspondingly greater exposure to infection.

DEATH RATE

The general death rate from typhoid was 0.05 per 1,000 per annum. The recorded case fatality rate was approximately 15 per cent. For the reasons pointed out elsewhere this is considerably higher than actually occurred.

Complete investigation of localized outbreaks and comprehensive studies of large groups of cases indicate that the case fatality rate was approximately 11 per cent and were exact data available it doubtless would be found to have been less than 10 per cent.

DISCHARGE ON ACCOUNT OF DISABILITY

A total of 24 men were discharged from the service on account of disability resulting from an attack of typhoid. Of the total number of individuals discharged for disabilities resulting from diseases, only 0.014 per cent were discharged for disabilities incident to typhoid, and in the list of the 30 diseases most frequently resulting in discharge for disability typhoid does not appear.

NONEFFECTIVE RATES

A total of 1,529 primary admissions for typhoid were reported and these men were absent from duty a total of 109,374 days. The average loss of time from duty per case of typhoid was, therefore, 72 days.

SEASONAL DISTRIBUTION

In general, the seasonal distribution in troops during the World War conformed to the well-known seasonal distribution of typhoid fever in temperate and cold climates—highest incidence in the late summer and fall months, particularly for cases developing in the United States. In Europe, however, a very considerable proportion of the cases arose during the winter months—November, 1918, to March, 1919, inclusive—due, doubtless, to increasingly constant exposure to massive doses of the infective agent.

GEOGRAPHICAL DISTRIBUTION

The recorded mortality rate for the civilian population of Manila, Philippine Islands, for the period 1917 to 1919, inclusive, was 1.84 [12] per 1,000 per annum, while that for American and Filipino troops serving in the Philippines during the same period of time was practically nil (1 case, or 0.05 per 1,000, for the period).

The admission rate per 1,000 for total enlisted strength for the period was 2.57 for Hawaii, 0.54 for Europe, and 0.25 for the United States. Expressed in comparative ratios these figures mean that for every one case of typhoid fever occurring in troops in the United States approximately two cases occurred in troops in Europe and ten cases in troops serving in Hawaii.

TYPHOID FEVER IN HAWAII

An explosive outbreak of typhoid fever, definitely traced to the water supply, occurred at Schofield Barracks, Hawaii, in the fall of 1917. The following abstract summarizes the epidemiology of this outbreak: [13]

Schofield Barracks, the largest Army station in Hawaii, is located on the northern end of the island of Oahu, about 23 miles from Honolulu. The regular water supply for the station was obtained from two sources. The old section of the station was supplied mainly with water collected in tunnels and brought down through a system of tunnels and pipes from a range of mountains adjacent

to and to the west of the station. The new section of the station, about 1 mile distant, was supplied by a gravity system having its main intake in the Koolau Mountain Range in the headwaters of the fork of the Kaukonahua River on the opposite side of the island. This supply was not subject to contamination except that certain sections of the tunnels in the upper reaches were open. Overflow and additional small streams came together, below the intake for the regular supply, forming a stream at the bottom of the ravine. On this stream, below the intake for the permanent water supply, was located a pumping station to augment the permanent supply, when necessary. This auxiliary supply was not supposed to be used without previously informing the sanitary authorities, through whom instructions would emanate as to the proper treatment of the water. At times water from the auxiliary supply for the new post also was pumped to the old post to augment the permanent supply, but at no time was this done during the course of the epidemic to be reviewed. The pumping station for this auxiliary supply was located at the lowest point of the watershed and the water itself was subject to constant contamination from camps of Japanese laborers engaged in construction work on the water supply system at the time the outbreak of typhoid occurred. These camps were on the hillside below the water mains and about 45 feet above and 55 to 100 yards distant from the bed of the stream constituting the auxiliary supply.

In the early days of August, 1917, a Japanese laborer arrived at one of the camps and, though he did not report for treatment, it was learned at a later date that he was ill for some time with a continued fever that doubtless was typhoid. While ill, he was visited by a Japanese friend (Mizusawa) employed at one of the construction camps. Mizusawa had not been inoculated against typhoid fever and came down with typhoid fever during the latter part of August. He worked for several days after he became ill, continuing to live at the camp, and he failed to report for treatment. He stopped work on September 1, but remained at camp until September 7. He was admitted to hospital in Honolulu on September 15 and was having hemorrhages from his intestines at that time. This patient was interrogated at the time the epidemic was under investigation and examination of his blood gave a positive agglutination reaction with *B. typhosus* in high dilution. While at the quartermaster construction camp this man had used an insanitary privy located on the drainage shed of the stream constituting the source of the auxiliary water supply for the new section of Schofield Barracks.

From the middle of August to the middle of September, 1917, the rainfall on the watershed of the regular water supply system for the newer part of the post was so low that it became necessary, more or less constantly, to supplement the regular supply with water from the auxiliary system. The sanitary authorities at Schofield Barracks had no knowledge of the fact that this was being done. On September 13 and 14 rather heavy rains occurred on the watershed used as an auxiliary water suppy and following these rains it was noted at Schofield Barracks that the water from the source was quite muddy. Within 10 days after these heavy rains fell cases of typhoid fever began to appear, and within a comparatively short period of time 100 cases had occurred. All individuals who contracted the disease gave a history of drinking the contaminated water

within the incubation period of the disease. Of the total population—military and civilian—exposed to infection, 4,087 had been vaccinated with antityphoid-paratyphoid vaccine and 812 had not been so protected. No persons living in the older section of the post contracted typhoid except an occasional individual who gave a definite history of drinking water in the newer section of the post on the evening of September 14 or the following day. The comparative morbidity and mortality rates from typhoid fever in these two groups are shown in Table 5.

TABLE 5.—*Typhoid fever. Schofield Barracks, Hawaii. Vaccinated and unvaccinated groups, population, admissions and deaths. Absolute numbers, with rates per 1,000 and case fatality* [a]

Groups	Population	Admissions		Deaths		Case fatality per cent
		Absolute numbers	Rate per 1,000	Absolute numbers	Rate per 1,000	
Vaccinated groups	4,087	55	13.46	4	0.98	7.27
Unvaccinated groups	812	45	55.42	7	8.62	15.56

[a] Source of information: Russell, F. F.: Typhoid fever in the American Army during the World War. *The Journal of the American Medical Association*, Chicago, lxxii, Dec. 20, 1919, 1863.

These statistics demonstrate conclusively the protective value of prophylactic vaccination, the relative morbidity rate for the nonvaccinated to vaccinated being approximately 4 to 1. They show also that the complete eradication and prevention of typhoid can be accomplished only by a combination of prophylactic vaccination and efficient environmental sanitation and personal hygiene. The lower case mortality rate in the vaccinated group is confirmatory of other observations that appear in medical literature.

TYPHOID FEVER IN EUROPE (RUSSIA EXCEPTED)

The greater frequency of occurrence of typhoid in American troops on active service in France than in the United States justifies a somewhat detailed discussion of the epidemiology of the disease in the former area of activity. In the United States many of the cases occurred in unvaccinated individuals, but all troops in Europe presumably had been vaccinated; in the United States environmental sanitation in mobilization camps was excellent, while in Europe many defects existed, particularly so in the battle areas where the military objectives necessary of attainment prevented proper attention to sanitation; and general exposure to typhoid infection was much greater in France than in the United States.

The prevalence of typhoid fever in American Expeditionary Forces for the period of the World War is shown in Table 3. The total number of cases recorded as primary admissions was 885 (0.53 per 1,000). The occurrence of the cases by months is presented graphically in Chart IV.

The data incorporated in Chart IV pertain to all bacteriologically proven, as well as clinically diagnosed but not bacteriologically proven, cases of typhoid fever reported to the chief surgeon's office, A. E. F. They include also cases reported as primary admissions for typhoid fever as well as cases of typhoid

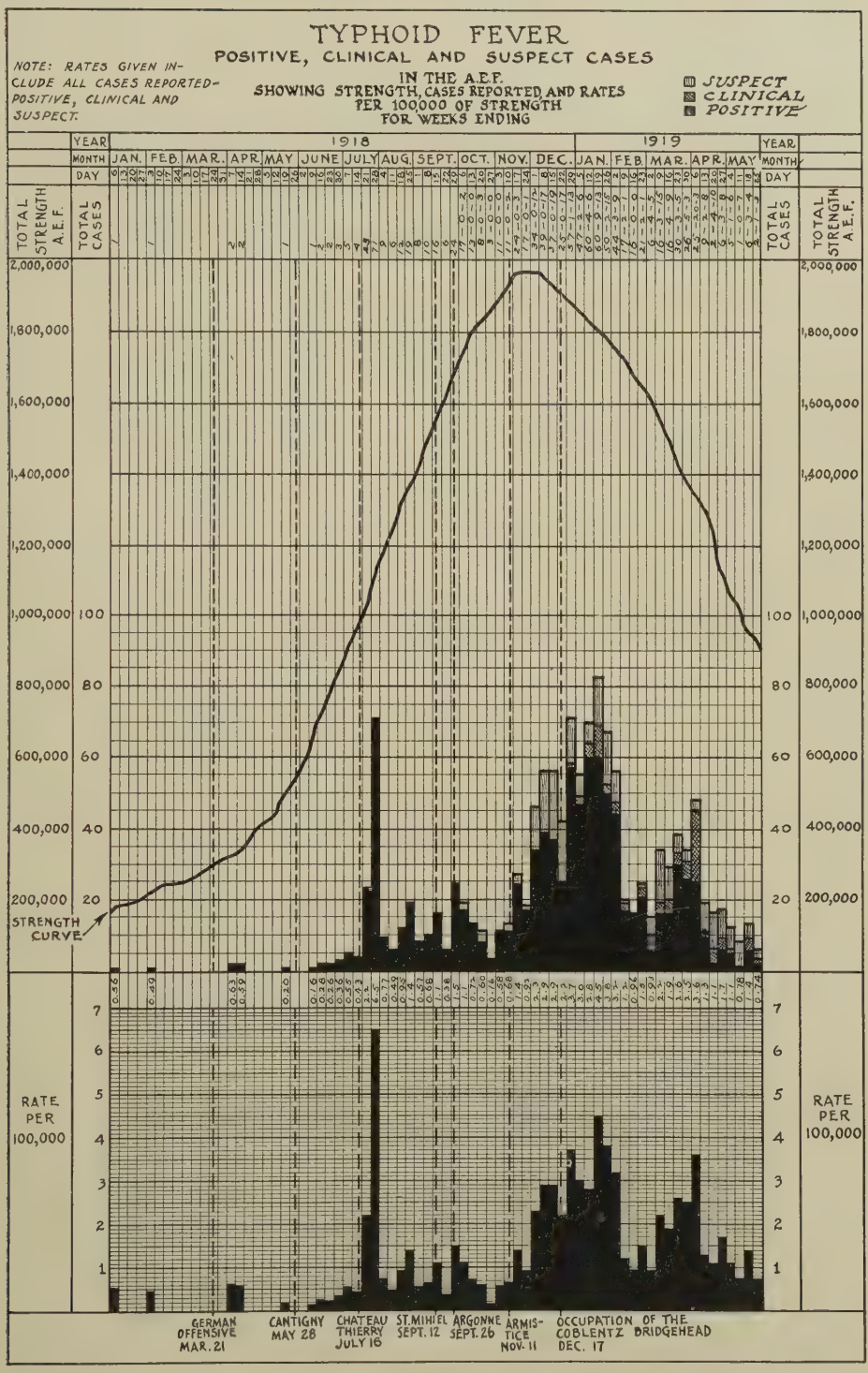
TYPHOID FEVER
POSITIVE, CLINICAL AND SUSPECT CASES
IN THE A.E.F.
SHOWING STRENGTH, CASES REPORTED AND RATES PER 100000 OF STRENGTH FOR WEEKS ENDING
NOTE: RATES GIVEN INCLUDE ALL CASES REPORTED-POSITIVE, CLINICAL AND SUSPECT.
SUSPECT
CLINICAL
POSITIVE
YEAR
1918
1919
MONTH
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY
DAY
TOTAL STRENGTH A.E.F.
TOTAL CASES
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
100
80
60
40
20
STRENGTH CURVE
RATE PER 100,000
7
6
5
4
3
2
1
GERMAN OFFENSIVE MAR. 21
CANTIGNY MAY 28
CHATEAU THIERRY JULY 18
ST. MIHIEL SEPT. 12
ARGONNE SEPT. 26
ARMISTICE NOV. 11
OCCUPATION OF THE COBLENTZ BRIDGEHEAD DEC. 17

CHART IV

complicating, or concurrent with, other diseases or battle injuries, and represent very closely the actual prevalence of typhoid fever in France. This chart shows that, prior to June, 1918, practically no typhoid fever occurred in American troops in France (there was a total of nine cases only); that an increase in the disease occurred in June, 1918, bringing the morbidity rate up to 0.03 and that again in December, 1918, and January to March, 1919, increases in rates occurred. The various elevations of the morbidity curve referred to above correspond with the occurrence in a few organizations located in various parts of France and more particularly the somewhat widespread but limited occurrence of the disease from November, 1918, to January, 1919, inclusive, in certain of the divisions that had taken part in the Meuse-Argonne operation.

That the origin and spread of typhoid fever in the American Expeditionary Forces were due to defects in sanitation that usually operate to initiate and disseminate the disease is well shown in the review of the epidemiology of the more important of the outbreaks, namely, those occurring in—

	Cases
Company No. 4, Camp Cody replacement unit, July, 1918	95
77th Division, December, 1918, to January, 1919	122
79th Division, December, 1918, to March, 1919	61
88th Division, January, 1919, to March, 1919	21
Medical Department units at Curel, December, 1918, to January, 1919	72
Motor Transport Camp, Marseille, March, 1919	64

Typhoid Fever in Company No. 4, Camp Cody Replacement Company

On June 15, 1918, three replacement units left Camp Cody, Deming, N. Mex., for Camp Merritt, N. J., en route to France.[14] Company No. 4, with an enlisted strength of approximately 248 men, was a provisional one, both commissioned and enlisted personnel being made up of individuals casually attached by transfer. All three companies arrived at Camp Merritt, N. J., on June 21, and none reported any serious illness. Company No. 4 was the only one of the three in which typhoid fever occurred.

Company No. 4 sailed for England on June 28, arriving in Liverpool on July 11. During the passage across the Atlantic many cases of so-called seasickness were reported, of which doubtless a considerable proportion were in reality typhoid fever. The company left Liverpool on July 11 and arrived in St. Aignan, France, via Cherbourg, shortly thereafter. During this trip, typhoid suspects transferred to hospital were as follows: July 11, Liverpool, England, 3; July 12, Romsey, England, 4; July 14, Southampton, England, 34; July 15, Cherbourg, France, 17; July (date unknown), St. Aignan, France, 3. Men continued to be taken ill for a period of 10 days after the arrival of the company at St. Aignan, the last case of typhoid having been admitted to hospital on July 28.

The following information is summarized from reports of investigation of the outbreak in England [14] and France.[15]

The incubation period of a large proportion of the cases was of such length as to indicate that most of the men contracted the disease while traveling by train from Camp Cody, N. Mex., to New York. The three companies traveled on the same train, but cases of typhoid arose in Company No. 4 only. So far as could be ascertained by inquiry, general sanitary conditions on the train were alike for the three companies.

The data on the service records and other evidence obtained indicated that antityphoid-paratyphoid vaccines had been given to all men in Company No. 4 at Camp Cody. Two of the men first taken ill in England stated that they had not felt well prior to their departure from Camp Cody, but had not reported themselves to a medical officer because of their eagerness to go to France. One of these men developed a severe diarrhea, with cramps, while en route to New York. The other man who did not have typhoid during the outbreak was later proven to be a typhoid bacillus carrier. A kitchen car was used in common by Companies No. 3 and No. 4, the personnel of one company being located in tourist sleeping cars in front of the kitchen car and that of the other company behind the kitchen car. The drinking water used by Company No. 4 was distributed from the usual type of water tank used on American railway cars and was not readily subject to contamination on the train. There was, however, a supplementary supply for Company No. 4, consisting of a large open barrel filled with water and placed in the vestibule between two of the sleeping cars. This could very easily have become contaminated, as the only means for obtaining water was by dipping the tin cup or canteen in the barrel. Washing and toilet facilities aboard the train were taxed to the limit.

Available evidence suggests that two of the men in the company were in the early stages of typhoid during the railway trip, that there was one bacillus carrier in the company, and that in all probability the unprotected drinking water in the open barrel was grossly contaminated by an individual or individuals in the early stages of the disease or by carriers of the organism. Certain it is that the defects in environmental sanitation were more marked during the railway trip than at any other stage of the journey to France.

In no other instance during the World War did such a large number of cases of typhoid fever occur in any one company, and in no other outbreak was the spread of the infection so sharply restricted. Ninety-five cases occurred in an organization with a total strength of 248 men and the case death rate was 8.3 per cent (8 deaths). The outbreak in this organization was most carefully studied both clinically and bacteriologically and the diagnosis was confirmed bacteriologically in a large proportion of the cases.

Typhoid and Paratyphoid Fevers in the 77th Division

This division took an active part in the Meuse-Argonne operation. Typhoid fever was known to have prevailed previously in endemic form in this sector, having been reported in both allied and enemy troops. The initial cases of typhoid fever in the division appeared during November, 1918, and failure to enforce sanitary discipline resulted in further spread of the disease during December, 1918, and January, 1919. An epidemiological investigation of the occurrence of typhoid and paratyphoid fevers in this division was made,[16] the report of which is the source of the following summary:

During the period November, 1918, to January, 1919, inclusive, a total of 97 cases of typhoid and 25 of paratyphoid fevers occurred in the division. Eighteen of the cases appeared in November, 1918; 79 in December, 1918; and 25 in January, 1919. So far as could be determined, typhoid-paratyphoid

vaccine had been administered to the entire division. Of the total number of cases of typhoid and paratyphoid fevers, 74 occurred in one regiment, namely, the 307th Infantry, and most of the cases arising in this regiment were reported from the 2d and 3d Battalions. These two battalions, after the armistice, were stationed in small towns along the river Aube. These valley towns were flooded during the entire period from December, 1918, to January, 1919, and great difficulty was experienced in providing proper latrines, particularly in the town of Clairvaux, at which place it was necessary to move one of the latrines four times because of high water. All organizations of the divisions, except the 2d and 3d Battalions, 307th Infantry, and Company E, 305th Infantry, were located on somewhat higher and better drained ground during this period.

Investigation of the outbreak indicated that sanitary discipline in the division was poor, that some units were without company water bags for several days, and that after water bags were obtained and the water was chlorinated many men continued to use water from unauthorized sources, claiming that the water furnished was overchlorinated and unpalatable. Inspection of the chlorination of water supplies used by the division disclosed the fact that in 35 per cent of the supplies no trace of excess chlorine could be demonstrated and in approximately 20 per cent of the water bags such great excess of chlorine was present as to render the water unpalatable.

The evidence collected indicated that a few men in this division picked up typhoid or paratyphoid in the Argonne, that after the armistice the division was stationed in areas of typhoid endemicity, that the gradual spread of the disease was due to poor sanitary discipline, and that in the organizations in which lowered morale and poor discipline were most evident and sanitary defects were most difficult to remedy the disease gained greatest headway and was most difficult to eradicate.

Typhoid Fever in the 79th Division

Diarrhea prevailed somewhat extensively in the 79th Division during October and November, 1918, diminishing during December and January. All regiments were involved, particularly the 315th and 316th Infantry.[17] Troop movements of the division are of interest as during the latter part of October and the first part of November the regiments occupied territory around Etraye, Reville, Crepion, and Gibercy. This region had been occupied by German troops, and that diseases of the intestines were common in this area is shown by the fact that the German hospital near Damvillers had special latrines reserved for "intestinal cases." All regiments of the division, at one time or another, occupied the Etraye and Crepion areas. The 313th Infantry was removed from this locality on November 23 and the 314th on November 11, while the 315th and 316th remained until December 26, 1918.

While in action during the first part of November the troops drank water from shell holes, springs, wells, and surface water wherever found. Diarrhea became so general that 50 per cent or more of the personnel of the division was affected and 61 of the cases were diagnosed definitely as being typhoid fever.

An investigation for typhoid carriers was undertaken in the 315th Infantry, the cooks and permanent kitchen police (336) being examined. Of these, 57 gave a history of diarrhea. Nine carriers were found (eight typhoid

and one paratyphoid *A*). Samples of water from various sources in and about Crepion, Etraye, and Reville gave positive tests for *B. coli*. The evidence gathered indicated that the initial cases were acquired by drinking contaminated water and that the spread of the disease was due mainly to carriers. Sanitary discipline in this division was not good.

Typhoid Fever in the 88th Division

An outbreak of typhoid fever occurred in the 88th Division in the early part of 1919, limited very largely to the 2d Battalion, 350th Infantry, located at Morlaincourt.[17] A total of 12 cases occurred, the highest number for a single week having been reported during the week February 12–18, 1919. The investigation of this outbreak disclosed the fact that there were three sources of water to which this organization had access. One source was found to be potable, and no cases of typhoid fever arose among the men using this water exclusively. The two remaining sources were found to be grossly contaminated, one of them arising as a spring under a house in which there was a case of typhoid fever. There were at least 27 cases of the disease among civilians, and soldiers were billeted in a number of houses in which cases of typhoid were present. Eleven soldiers living in such houses contracted the disease.

Typhoid Fever in Medical Department Units at Curel, France

In December, 1918, and January, 1919, there occurred among troops billeted at Curel (Haute Marne), France, an outbreak of typhoid fever with 72 cases.[18] Twenty-one deaths occurred, but it is known that a large number of secondary pneumonias developed as complicating factors, and the case mortality rate from typhoid itself was not excessive.

The troops stationed at Curel numbered about 70 officers and 1,782 men, constituting the personnel of Evacuation Hospitals Nos. 25, 31, 32, 33, 34, and 35; Mobile Hospitals Nos. 100, 101, 102, 103; and the 106th, 113th, and 301st Sanitary Trains, the first and third of these being skeletonized. All had one or more cases of typhoid fever except Mobile Hospital No. 101 and the skeletonized sanitary trains. Evacuation Hospital No. 33 had 28 cases, 39 per cent of the total, and Evacuation Hospital No. 25, 15 cases, or 21 per cent of the total.

The first organization arrived in this area November 29, the others continuing to arrive until December 8, 1918. Water was not chlorinated from November 29 to December 9 because of lack of supplies of hypochlorite. The supply of hypochlorite was again exhausted December 20, and did not again become available until December 27.

The water supply of the village was from four springs and many wells. No sanitary survey of the water supply was made by American medical authorities until after the epidemic was under way; a survey made at that time indicated that all the village water was nonpotable in its raw state. The chief source of water supply for the troops was a spring, within a radius of 125 feet of which were six privy vaults, four being on ground higher than the spring. All were overflowing with fecal matter.

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Some cases of diarrheal disease were reported among the inhabitants of Curel, but no typical typhoid fever was seen. There was no diarrhea or gastrointestinal disturbance among any of the organizations prior to their arrival at Curel and none of the organizations stationed there had seen service in any of the front areas. Approximately 75 per cent of the troops suffered with diarrhea during their stay at Curel. Gastrointestinal disturbance commenced a few days after arrival of each contingent and persisted until January 7, when it began to diminish, finally disappearing altogether on January 18. As a rule, the diarrhea was not severe in character, persisted for a few days only, the stools were not bloody, and there was no fever.

Cases of typhoid fever began to appear on December 19, reaching the maximum in number on January 2, declining thereafter but persisting until January 15. No contact relationships could be established. The organizations having the largest number of cases were billeted in sections of the village far distant the one from the other.

The individual service records of the personnel and other information available indicated that all men had been vaccinated against typhoid and paratyphoid fevers. Some of the men were among the later draftees and had received lipovaccine, but there appeared to be no relationship between the prevalence of typhoid fever in the various units and the type of vaccine used or the length of time elapsing since vaccination. The general character of the epidemic, its rapid rise to a peak and sharp decline, with no definite remissions, pointed to a water-borne epidemic. Confirmatory of this interpretation is the fact that the incubation period for most of the cases indicated that infection was acquired during the time when the water was not treated. When regular and continuous chlorination of the water was begun, on December 27, the incidence rate dropped rapidly and the outbreak came to an end.

Typhoid Fever in the Motor Reception Park, Marseille

Typhoid fever occurred in motor reception park No. 752 in Marseille from the latter part of February to the latter part of April, 1919.[19] There were 64 cases with 7 deaths (case mortality, 11 per cent). The epidemic was clearly proved to be of water-borne origin. The camp was divided into three sections, A, B, and C. All cases occurred in section C. The water supply for sections A and B was the regular supply used by the city of Marseille, which passed through a central sedimentation plant before use. It was probably not above reproach, but the sedimentation process reduced the contamination to a minimum. The water supply for section C was an offshoot from the regular city supply. It was piped into camp from an open canal which wound for many kilometers through villages, past farm houses, and country roads. Along the banks of this canal deposits of human feces frequently were observed. These disappeared after rainstorms, being washed into the canal. The water as it arrived at camp was full of worms, snail shells, and much organic sediment. Three open taps were installed in section C, for the purpose of washing trucks and filling their radiators. On investigation it was found that 31 of the first 33 patients admitted having drunk the raw water from these taps more than half the time, despite warnings issued against drinking this raw water and ready access to Lyster bags in which was an abundance of treated water. Correction of existing defects in the water supply in section C brought the outbreak to an end.

Minor Outbreaks of Typhoid Fever

Of minor outbreaks of typhoid fever that occurred in various parts of France the following were the more important: In an Engineer detachment at Bazoilles,[20] 15 cases, August, 1918; 323d Infantry, 81st Division, 10 cases, December, 1918; Battery E, 321st Field Artillery, 82d Division, 22 cases, January and February, 1919. These and other minor outbreaks were carefully investigated and their epidemiology was of like nature to that of the outbreaks reviewed above.

In the American Third Army in Germany.—The discussion of typhoid fever in our armies in Europe would be incomplete without brief reference to its occurrence in the American Third Army in Germany, which is summarized in the following quotation:[21]

> Typhoid fever has been present in the Third Army since its formation, but the incidence of this disease has fallen off noticeably since the army has settled down and opportunity has been afforded for the establishment of improved sanitation. During the interval, December 22 to March 11, 63 cases of typhoid fever were reported from organizations of the Third Army. An analysis of these cases with reference to date of onset of the disease brought out the fact that in the majority infection was acquired either during the march to the occupied territory or in the days immediately following the arrival of organizations at their destinations. Since that time the incidence of typhoid fever in the army has been in no sense alarming, and in one or two instances the infection was known to have been acquired outside the occupied territory. Revaccination of the army with lipovaccine was commenced in March.

TYPHOID FEVER IN THE UNITED STATES

The total number of cases of typhoid fever recorded as primary admissions in the United States during the World War was 546 (0.24 per 1,000 strength). The morbidity rates for all the large mobilization camps are tabulated in Table 6.

Table 6.—*Typhoid fever. Admissions, enlisted men, by camps, September 1, 1917, to December 31, 1918. Absolute numbers and rates per 1,000* [a]

Camps	1917 (September-December)		1918		Camps	1917 (September-December)		1918	
	Absolute numbers	Rates per 1,000 strength	Absolute numbers	Rates per 1,000 strength		Absolute numbers	Rates per 1,000 strength	Absolute numbers	Rates per 1,000 strength
Beauregard, La	2	0.51	3	0.19	Logan, Tex	3	0.33	2	0.11
Bowie, Tex	13	1.78	4	.24	MacArthur, Tex	19	2.53	2	.11
Cody, N. Mex			1	.06	McClellan, Ala	10	1.03	2	.10
Custer, Mich			4	.15	Meade, Md			8	.23
Devens, Mass	1	.12			Mills, N. Y			1	.07
Dix, N. J	20	3.15	2	.06	Pike, Ark	4	.47	10	.28
Dodge, Iowa	1	.16	2	.07	Sevier, S. C	4	.56	4	.20
Doniphan, Okla	7	.98	1	.05	Shelby, Miss	1	.14	9	.43
Fremont, Calif			2	.13	Sheridan, Ala	9	1.52	5	.27
Funston, Kans	1	.10	4	.10	Sherman, Ohio	1	.11	1	.04
Gordon, Ga	1	.13	8	.25	Syracuse, N. Y			1	.30
Grant, Ill	1	.14	1	.03	Taylor, Ky	4	.60	8	.25
Greene, N. C			11	.54	Travis, Tex	7	.82	7	.23
Hancock, Ga	4	.45			Upton, N. Y			3	.11
Jackson, S. C	2	.25	8	.28	Wadsworth, S. C	1	.11	5	.23
Johnston, Fla			3	.14	Wheeler, Ga			1	.05
Lee, Va	2	.26	17	.42					
Lewis, Wash	2	.19	5	.16	Total	120	.48	145	.19

[a] Source of information: Annual Reports of the Surgeon General, U. S. Army, 1918, pp. 118, 119, and 1919, pp. 922, 923.

The tabulation includes the years 1917 September to December and 1918 only, as many of the mobilization camps were closed by the early months of 1919. No cases whatsoever of typhoid fever occurred in one-third (10) of the camps listed in Table 6 during 1917 and in one-fifteenth of the camps in 1918. In 33 per cent of the camps less than three cases were reported in 1917, while 44 per cent of the camps reported less than three cases during the year 1918. More than 50 per cent of the cases recorded in this table occurred in individuals who reported at mobilization camps in the incubatory stage of the disease.

The conclusion to be drawn from the information set forth in this table is that, compared with our experience during the Spanish-American War, scarcely any typhoid fever occurred in our mobilization camps. It also evidences the fact that very rapid progress has been made in the eradication of typhoid fever in the civil population throughout the United States of America since the Spanish-American War.

The other very important reversal of our Spanish-American War experience is that while one or more cases of typhoid fever occurred in all camps—Camp Kearny, Calif., excepted—at some time during the World War, the disease did not become disseminated throughout the commands as was so universally the case during the Spanish-American War.

That a large proportion of the 546 individuals who had typhoid fever in the United States had contracted the disease before protection could have been afforded by vaccination is evident from the following abstracts from reports on file in the Office of the Surgeon General of the Army. The surgeon at Camp Devens, Mass., reported that the case of typhoid fever reported from that camp in 1917 occurred in a drafted man five days after his arrival at camp.[22] The surgeon at Camp Dix, N. J., reported that the 14 cases of typhoid occurring in that camp during October, 1917, were probably brought in by the September increment of drafted men.[23] The surgeon at Camp Sherman, Ohio, reported that the one case of typhoid fever in that camp in 1917 was contracted by the soldier at Prospect, Ohio, and the man never had been vaccinated.[24] The same surgeon reported 12 cases (not included in Table 6, as the cases arose prior to federalization) in Company H, 3d Ohio Infantry, that were charged to sources other than those for the camp. None of the men had been protected by vaccination, and had probably contracted the disease by drinking water from a condemned well at Springfield, Ohio. There were seven cases at Camp Travis in 1917, all brought in from outside sources. The triple vaccine offered general immunity.[25] The 10 cases reported at Camp McClellan in 1917 occurred in the 5th New Jersey Infantry. The cases were brought into the camp, and examination of the individual service records of the command showed that in practically every instance protective inoculation had not been completed.

The camp surgeon at Camp Gordon, Ga., reported that a few cases of typhoid fever were treated in the hospital during 1918, but it was possible to establish in every instance the fact that the individual brought the infection to camp with him.[26] The camp surgeon at Camp Shelby, Miss., reported that this relatively rare disease in the Army camps was introduced in this camp when there appeared 4 cases in July and 4 cases in August who were either

suffering from clinical typhoid fever when they entrained or gave manifestation of the disease after being in the camp only a few days.[26] Among the 8 cases of proved typhoid fever, 4 cases had received no typhoid inoculation, 2 cases only one dose, and 2 had two inoculations. The camp surgeon at Camp Greene, N. C., reported that typhoid fever occurred in a small number of cases, particularly in a small epidemic in June and July, 1918, and mostly in recruits who had not been inoculated.[26]

Of 74 deaths from typhoid fever among enlisted personnel serving in the United States, 41, or 55 per cent, occurred in individuals who had been on active service for less than two months and these doubtless were deaths from typhoid fever in individuals who either had not been given protective inoculations or in whom no active immunity had been produced for one reason or another.

In so far as the military forces serving in the United States are concerned there is ample justification for the statement that no epidemics of typhoid fever occurred throughout the period of the war. This triumph in preventive medicine is attributable to three factors—antityphoid inoculation; excellent environmental sanitation; and the progress made in the gradual elimination of typhoid fever from the civil population during the two preceding decades.

The one outbreak of typhoid fever among civilians under governmental but nonmilitary control in the United States that assumed epidemic proportions occurred at one of the camps for interned enemy aliens at Hot Springs, N. C., in the summer of 1918.[27] The essential epidemiological features of this outbreak are as follows:

The epidemic, consisting of a total of 183 cases, was limited to enemy aliens in the internment camp, and the cases were transferred for treatment to United States Army General Hospital No. 12, located at Biltmore, N. C., about 50 miles distant. The epidemic was directly traceable to accidental contamination of the water supply of one section of the camp, which was connected, for fire-prevention purposes only, with an intake from the French Broad River, afterward found to be contaminated.

The epidemic began July 1, 1918, when 4 men became ill with typhoid fever. During the month of July, 88 cases occurred and during August, 95. August 23 marked the onset of the last case. At the beginning of the epidemic none of the interned aliens had been protected by inoculation against typhoid. Prophylactic inoculations with antityphoid vaccine first were offered as a voluntary measure, but the response was so poor that it was decided to make the vaccination compulsory. This was done August 1.

The cases studied in this epidemic fall into four groups: The first consisted of uninoculated, 70 patients; the second of 73 who had received 1 inoculation; the third of 21 who had received 2 inoculations; and the fourth of 4 cases with 3 inoculations. The degree of protection furnished by the belated effort to immunize men at the internment camp at Hot Springs is uncertain. Efforts were made to determine the relative degree of protection afforded by vaccination during the epidemic, the comparative study being based on the four groups mentioned above. The average duration of fever in uncomplicated cases

in the first group (unprotected) was 37 days, in the second group (1 inoculation) 31 days, and in the third and fourth groups 24 and 29 days, respectively.

In the first group 18 per cent of the cases developed complications, in the second group only 12 per cent, and in the third and fourth groups no complications appeared. In the 13 noninoculated cases with complications the average duration of fever was 80 days, and in 9 patients with complications who had received 1 inoculation the average duration of fever was 64 days.

OCCURRENCE OF TYPHOID FEVER IN THE ARMIES OF SEVEN OF THE NATIONS PARTICIPATING IN THE WORLD WAR

A comparison of the rates of prevalence of typhoid in the armies of the various nations engaged in the World War (Great Britain, France, Italy, Belgium, Germany, Austria, and the United States) is of more than passing interest, particularly if analyzed from the viewpoint of the preventive measures initiated by the armies of each nation. Complete statistical data are not available; however, sufficient information is at hand to warrant its tabulation and discussion. This information is given in Table 7.

TABLE 7.—*Typhoid fever. By years of occurrence in the armies of seven of the important nations involved in the World War, showing number of cases and deaths with ratios per 1,000 per annum, and case fatality rates, 1914 to 1919* [a]

Country	1914					1915				
	Cases		Deaths		Case fatality (per cent)	Cases		Deaths		Case fatality (per cent)
	Absolute numbers	Ratio per 1,000	Absolute numbers	Ratio per 1,000		Absolute numbers	Ratio per 1,000	Absolute numbers	Ratio per 1,000	
United States	7	0.07	3	0.03	42.86	8	0.08			
Great Britain	388		47		12.11	2,351	4.00	130	0.22	5.53
France	45,450		8,170		17.98	64,561		6,312		9.78
Italy						18,655	18.01			
Belgium	524	6.14	121	1.42	23.09	1,900	10.30	324	1.76	17.05
Germany						43,681		7,964		18.23
Austria	7,188		844		11.74	125,771		13,573		10.79

Country	1916					1917				
	Cases		Deaths		Case fatality (per cent)	Cases		Deaths		Case fatality (per cent)
	Absolute numbers	Ratio per 1,000	Absolute numbers	Ratio per 1,000		Absolute numbers	Ratio per 1,000	Absolute numbers	Ratio per 1,000	
United States	25	0.23	3	0.03	12.00	297	0.44	23	0.03	7.74
Great Britain	2,568	2.02	30	.02	1.17	1,166	.61	33	.01	2.83
France	12,656		484		3.82	1,659		135		8.14
Italy	28,142	11.95				7,773	2.58			
Belgium	335	1.72	22	.11	6.57	240	1.13	13	.06	5.42
Germany	31,180		1,892		6.07	16,571		623		3.76
Austria	24,292		1,570		6.46	9,551		748		7.83

[a] Source of information: (1) Monthly sick and wounded reports of the Surgeon General, for the years 1914 to 1919, inclusive. (2) Official History of the War, Medical Services, Diseases of the War, vol. 1, p. 11. (3) Dopter, M.: Les Maladies Infectieuses pendant la Guerre, Librairie Felix Alcan, Paris, 1921, p. 45. (4) Document on file in the historical division of the Surgeon General's Office. (5) Document on file in the historical division of the Surgeon General's Office, (6) Handbuch der Arztlichen Erfahrungen im Weltkriege, Band iii, Inner Medizin, Leipzig, 1921 87. (7) Document on file in the historical division of the Surgeon General's Office.

TABLE 7.—*Typhoid fever. By years of occurrence in the armies of seven of the important nations involved in the World War, showing number of cases and deaths with ratios per 1,000 per annum, and case fatality rates, 1914 to 1919*—Continued

Country	1918					1919				
	Cases		Deaths		Case fatality (per cent)	Cases		Deaths		Case fatality (per cent)
	Absolute numbers	Ratio per 1,000	Absolute numbers	Ratio per 1,000		Absolute numbers	Ratio per 1,000	Absolute numbers	Ratio per 1,000	
United States	768	0.30	133	0.05	17.32	467	0.47	71	0.07	15.20
Great Britain	334	.12	20	.01	5.99					
France	665		110		16.54					
Italy	3,881	1.31								
Belgium	187	.89	24	.11	12.83	31		19		61.29
Germany	20,932		926		4.42					
Austria	4,799		664		13.84					

TOTAL FOR THE PERIOD

Country	Cases		Deaths		Case fatality (per cent)
	Absolute numbers	Ratio per 1,000	Absolute numbers	Ratio per 1,000	
United States	1,572	0.35	233	0.05	14.82
Great Britain	6,807	1.02	260	.04	3.82
France	124,991	14.86	15,211	1.81	12.17
Italy	58,451	6.24			
Belgium	3,217	3.59	523	.57	16.26
Germany	112,364		11,405		10.15
Austria	171,601		17,399		10.14

The interpretation of the data compiled in the table is somewhat complicated by the fact that the figures given for France and Italy include not only typhoid but also the paratyphoid fevers, while those for the remaining five nations are confined to typhoid. It may be assumed, however, that the vast majority of the cases occurring in both the French and Italian Armies were typhoid. A further complication arises from the fact that Italy did not engage in hostilities until 1915 and the United States not until the spring of 1917. It should be noted, however, that the statistics for the United States Army include the cases occurring during 1919, while those for the armies of the other nations (except Italy and Germany) cover the period 1914–1918, inclusive.

It may safely be assumed that the armies of all the nations concerned were well acquainted with the generally accepted principles that form the basis for the control and prevention of the enteric group of fevers, and that all well-known general preventive measures were enforced in so far as military necessity would permit. We will limit ourselves, therefore, to an inquiry as to the extent to which anti-typhoid-paratyphoid vaccines were used as a prophylactic measure by the armies of the various nations and the degree of success—prevention of typhoid fever—attending their use.

UNITED STATES ARMY

The United States Army was the only one of the seven under consideration in which the policy, initiated several years previous to our entrance into the World War, was continued and actually carried into effect, of making mandatory the vaccination of all military personnel immediately after their entry into the service and of using a triple vaccine—typhoid-paratyphoid A and paratyphoid B—for protective purposes.

Our admission (morbidity) rate per 1,000 for typhoid fever was the lowest attained by the armies of any of the nations participating in the conflict.

Approximately one-fourth of the cases arose after the cessation of hostilities, and the assumption is justified that though an exceedingly high degree of protection was afforded our troops by this measure the immunity was not a lasting one. It follows, therefore, that even though three consecutive doses of vaccine are given for protective purposes the repetition of the series of inoculations may become necessary or desirable in time of war at less than three-year intervals. This procedure was actually adopted by our Army in the early months of 1919 and approximately 350,000 men were revaccinated in France.

BRITISH ARMY

During the course of the war (1914–1918), among approximately 4,970,902 [28] British (excluding colonials) called to the colors, about 20,149 cases were recorded as having had the typhoid fevers.[1] Leishman [10] reported that the British were able to inoculate, with a single dose of vaccine, about 25 to 30 per cent of the original expeditionary force before they crossed the channel, and that it was not long before the inoculation strength of their troops in France rose to a figure that fluctuated between 90 and 98 per cent

The regulations of the British Army at the outbreak of the war in 1914 provided for antityphoid inoculation for troops embarking for foreign service.[29] In consequence of the existing emergency, the first expeditionary force of 100,000 troops dispatched to the Western Front had been incompletely protected and soon after arrival in France typhoid fever began to appear. In 1915 and thereafter approximately 90 per cent of the troops dispatched for foreign service had received protective inoculations. Prior to departure from home territory it was the custom to give two consecutive doses of vaccine and repeat the series every two years. At no time was the use of this protective measure made mandatory for all troops. During 1914 and 1915 the vaccine consisted of typhoid bacilli alone, but the undue prevalence of the paratyphoid fevers A and B in troops in various theaters of activity made necessary the addition of the paratyphoid organisms, and from the beginning of 1916 to the end of the war the vaccine in use was a triple one (*B. typhosus*, and *B. paratyphosus A* and *B*).

As will be seen from Table 7 the rate of prevalence (morbidity per 1,000) decreased from year to year and, while in 1915, 4 men in every 1,000 had typhoid fever, by 1918 the rate had been reduced to 0.12 per 1,000. This reduction coincided with an increasingly widespread use of antityphoid vaccines as a preventive measure, and there is ample justification for the statement that the gradual elimination of typhoid fever from the British armies was attributable to protective inoculation.

FRENCH ARMY

Since no official figures from the French War Office relative to the prevalence of typhoid and the paratyphoid fevers, or with reference to the status of protective inoculations with typhoid-paratyphoid vaccines during the World War, are available, the data used herein were obtained from a report made by Dopter; [30] the statistics include both typhoid and the paratyphoid fevers. During the course of the war approximately 8,410,000 [31] men were called to active service by France, and during the same period of time approximately 125,000 cases of typhoid and the paratyphoid fevers occurred in the

French Army [30] (approximate rate per 1,000 for typhoid and the paratyphoids for the period, 14.86).

Antityphoid vaccine as a prophylactic measure was used in the French Army to a certain extent at the outbreak of the war (1914) but was not a compulsory measure for all troops. On account of the existing emergency only a small percentage of the military personnel was given protective inoculations during 1914, and as a consequence approximately 45,000 cases of typhoid and paratyphoid fevers occurred, most of which were typhoid.[30] Until September, 1915, an antityphoid vaccine was used, but a large porportion of the troops still were unprotected. It was noted in 1915 that, while some progress was being made in the control of typhoid, the cases of paratyphoid fever were increasing rapidly. In consequence of this fact a triple vaccine containing typhoid and paratyphoid A and B organisms was adopted and used from September, 1915, to the end of the war.

During the first two years of the war, and particularly so during 1914, when a considerable proportion of the French military forces had not received protective inoculations of antityphoid vaccine, large numbers of cases of typhoid occurred. Subsequent to September, 1915, however, when a triple vaccine was adopted and when military conditions permitted its more widespread use, both typhoid and the paratyphoid fevers were gradually brought under control, as is evidenced by the fact that during the first two years of the war (1914 and 1915) there were approximately 110,000 cases of these fevers, whereas during the last two years the total was approximately 2,000 cases.

ITALIAN ARMY

During the World War approximately 5,615,000 Italian subjects were called for active service with the Italian Army,[31] and of this number approximately 65,000 had typhoid or the paratyphoid fevers.[32] (Approximate rate per 1,000 for typhoid and the paratyphoid fevers for the period 6.24.) The use of antityphoid vaccine as a preventive measure was technically obligatory for the Italian Army when Italy entered the war in 1915, but it was found to be not feasible to carry it into effect during that year on account of the rapidity and urgency of mobilization. During 1916 and 1917 somewhat similar conditions obtained and though some progress was made a large proportion of the forces still remained unprotected.[32] During 1918 still greater efforts were made to inoculate the new drafts and not until that year were the enteric fevers controlled to any marked extent. Though during 1915 the vaccine consisted of the typhoid bacillus alone, from 1916 to the end of the war both typhoid and paratyphoid vaccines were used.

BELGIAN ARMY

During the course of hostilities approximately 267,000 Belgian subjects were called to the colors with the army,[31] and of this number approximately 3,200 had typhoid or paratyphoid fevers.[33] (Approximate rate per 1,000 for typhoid and paratyphoid for the period 13.1.) Approximately 90 per cent of the cases were typhoid and 10 per cent paratyphoid.

Prophylactic vaccination was not carried out in the Belgian Army prior to or at the beginning of the war in 1914, but was introduced in 1915, and by the end of that year 10 per cent of the forces had been protected.[33] During 1914 and

1915 approximately 2,500 cases of typhoid and the paratyphoid fevers occurred. From 1916 onward to the end of the war about 96 per cent of the personnel was protected, and during this three-year period approximately 1,000 cases were observed as compared with 2,500 for the preceding year and a half.

GERMAN ARMY

From 1915 to the end of the war approximately 112,000 cases of typhoid fever occurred in the German Army.[34] No information is available to us as to the extent to which prophylactic vaccines were used, the content of such vaccines, or the prevalence of the paratyphoid fevers in the German Army. Total mobilized forces amounted to 11,000,000 men.[31]

AUSTRIAN ARMY

From the beginning of the war in 1914 to the end of 1918 approximately 171,000 cases of typhoid occurred [35] among the 7,800,000 men Austria mobilized for the war.[31] The extent to which paratyphoid prevailed is not known nor is there available information concerning the extent to which prophylactic vaccination was practiced, or the type of vaccines used.

The data outlined above demonstrate most conclusively the value and importance of prophylactic vaccines (typhoid-paratyphoid) in the prevention of the enteric fevers and the very great importance of carrying this measure into effect at the time that troops are called to the colors.

PREVENTIVE MEASURES INAUGURATED IN THE ARMY DURING THE WORLD WAR

The general and special preventive measures carried out in the American Army for the control of typhoid fever and other communicable diseases are considered in detail in the volume on sanitation of this history; therefore, only brief reference is made to them in this chapter.

In so far as general preventive measures are concerned, it may be said that instruction in hygiene was made a matter of routine and every effort was made to safeguard the environment in accordance with modern conceptions of disease prevention.[36] To protect against the intestinal group of infections—typhoid, dysentery, and diarrhea—special attention was directed to the proper disposal of excreta and to the supply of potable drinking water. In the field the pit latrine system with fly-proof box seats was used generally, except in the battle areas. To each company or other organization of like nature was to be issued one or more canvas water-sterilizing bags, capacity 30 gallons, for the storage and distribution of drinking water. Sealed ampules of calcium hypochlorite were available for use in sterilizing supplies of water for drinking purposes. Investigation of outbreaks of typhoid and medical inspections of organizations frequently disclosed the fact that organizations either had no water-sterilizing bags or no calcium hypochlorite, or were provided with neither. Many company commanders apparently failed to appreciate the importance of having water-sterilizing bags and tubes of calcium hypochlorite always with the organization. In France the general distribution of tubes of calcium hypochlorite was a difficult problem and very unsatisfactorily solved until about the date of the signing of the armistice, when this item was issued as part of the ration. There

also was wide variation in the quantity of calcium hypochlorite in the tubes and the amount of available chlorine in the individual tubes varied within wide limits. Had all organizations in France had water-sterilizing bags and chlorine constantly available, together with good water discipline, and in addition, had it been possible to supply each soldier with a sterilizing agent to be carried on the person and to be used in emergency for the sterilization of water in the canteen, it is extremely doubtful if more than a hundred or so cases of typhoid would have occurred among the nearly 2,000,000 men in the American Expeditionary Forces.

The experiences of the Army with vaccines in the World War have their lessons for the future. The history of this subject may therefore be divided into several periods. In this connection it should be remembered that this account relates only to the manufacture of vaccines and does not correspond exactly to the actual use of the various products.

INTRODUCTION OF THE USE OF VACCINES (1908–16)

MONOVALENT SALINE VACCINE

After the experience of the Army with typhoid fever during the Spanish-American War, the officers of the Medical Corps in charge of the bacteriological laboratories of the Army Medical School devoted much attention to the problems of the prevention of the spread of typhoid. In 1908, Russell [37] took up the problem of typhoid vaccination on account of its sound theoretical basis and because of partial success of the use of vaccines in the British and German Armies. He worked out the technique of the production of a vaccine for subcutaneous injection, using the agglutinating power of rabbit's serum as an index of immunity. The procedure finally decided upon was a modification of the English broth vaccine and the German agar vaccine methods. The aim was to change the typhoid bacillus as little as possible by killing it at a minimum temperature of 53° C. for one hour. The organisms were suspended in salt solution and 0.25 per cent tricresol was added to prevent contamination. This amount of antiseptic was found not to injure the antigenic properties of the vaccine. The English strain "Rawlings," from a soldier of the Boer War, was selected from several strains as being most suitable for vaccine purposes.

The strength of the vaccine was 1,000 million bacilli per cubic centimeter as determined by the Wright method of counting. The doses were 0.5 c. c., 1.0 c. c., and 1.0 c. c. at 7 to 10 day intervals.

PARATYPHOID A AND B SALINE VACCINES (1916–17)

During the first period, while cases of typhoid were exceptional, several cases of paratyphoid A and B occurred each year in troops along the Mexican border, and these cases seemed to indicate a lack of cross immunity and the possible necessity of a mixed vaccine. In 1916 this problem became more acute as a small epidemic of paratyphoid A infections occurred in the Mexican expeditionary forces and also in the National Guard units stationed in Texas.[38] Paratyphoid B infections also occurred, but were less numerous. Under these conditions, several cultures were sent from the Army laboratories at Fort Sam Houston, Tex., and El Paso, Tex., to the Army Medical School, where they

were tested for suitability as vaccine strains. Paratyphoid A vaccine No. 1 was made on September 10, 1916, 1,000 million per cubic centimeter, for local use of our troops in Texas and Mexico. Six of the strains were used at first in different proportions in different lots. The first paratyphoid A and B mixed vaccine was made in 1916.[37] Two hundred million paratyphoid B organisms were added to the paratyphoid A vaccine. The reactions were reported as severe and from January 20 to May 22, 1917, only a paratyphoid A vaccine was issued.

In the meantime, the British had been suffering from paratyphoid infections in France for two years and had finally adopted a mixed vaccine. The cultures used were sent to the school by our observer with the British Army. "Mears" A and "Rowland" and "Cools" B were tried out experimentally.

THE PERIOD OF THE WORLD WAR (1917–18)

SALINE TRIPLE TYPHOID VACCINE

After the declaration of war by the United States on April 6, 1917, it was decided to use paratyphoid vaccine, and at first, on account of fear of severe reactions, a separate vaccine was introduced, made up chiefly of "Rogers" and "Mears" A and "Rowland" and "Cools" B. The strength of this vaccine was 750 million per cubic centimeter of each fraction, a total of 1,500 million per cubic centimeter. The administration of 6 doses of vaccine, 3 of monovalent typhoid, and 3 of paratyphoid seriously complicated the training schedules and the possibility of a mixed triple vaccine was again taken up. Such a vaccine, consisting of 1,000 million typhoid and 750 million each A and B, a total of 2,500 million per cubic centimeter, was made up and tested at Fort Leavenworth, Kans.[39] The reactions were not severe and the agglutination response was satisfactory. The vaccine was made of "Rawlings" typhoid, "Rogers" and "Mears" A, and "Rowland" and "Cools" B. The first lot was made on July 11, 1917, and this kind of vaccine constituted the bulk of the vaccine used in the war.

LIPOVACCINE (SEPTEMBER 30, 1918, TO MARCH 12, 1919)

In 1916 several French workers reported on the use of oils in the place of salt solution as a medium for bacterial vaccines. The advantages claimed for this method were, slow absorption, larger dosage with less reaction, and especially the efficiency of a single dose. These claims attracted the attention of the director of laboratories at the Army Medical School, Washington, D. C., and he, with his assistants, in the spring of 1918, conducted preliminary experiments in the manufacture and use of lipo-triple-typhoid vaccine.[40] Their experience apparently confirmed the claims, and the single dose was an especially strong administrative argument in preparing the Army quickly for action in France. In the fall of 1918 lipovaccine was officially adopted by the Surgeon General's Office.[41] The first lot was made on May 23, 1918, of para B.

The technique, briefly, was to grow the organisms in the regular way in Kolle flasks; the growth was washed off in a minimum of salt solution and centrifugalized to collect the bacteria. After November, 1918, a Sharples centrifuge was used for this purpose, and the organisms were grown in tryp-

broth. The centrifugate was collected and dried in a hot-air oven at 60° C. It was then weighed, ground up in a ball mill to a fine powder, and olive oil was used for suspension. The doses were in milligrans of dried organisms. The dose was 1 c. c. Each cubic centimeter contained 0.3 mg. of typhoid, para A and para B bacilli, representing a total of 7,500 million organisms. The plant at the school was greatly enlarged by a special apparatus for this work.

After the armistice was signed, and there was enough leisure to study the subject more thoroughly at the school, it was found that to prepare an entirely sterile product on a large scale was most difficult. Some of the typhoid organisms were not killed, and contaminating organisms from the air were difficult to exclude. It was also found that absorption was not slow; the organisms were rapidly extracted from the oil by the body fluids. Even more important, it developed that a single dose did not give the antibody response that follows the use of two and three injections.

On March 1, 1919, therefore, a return was made to saline vaccine, and the following circular letter was issued from the Surgeon General's Office:[42]

1. Beginning with date of receipt of this letter, saline triple typhoid vaccine and saline pneumococcus vaccine, Types I, II, and III, will be used in place of the corresponding lipovaccines used to date.

2. Lipovaccines were adopted as a war measure on account of their obvious advantages and have served their purpose. The technique of manufacture, however, needs further improvement, and the duration of their protective power as compared with that of saline vaccines needs further investigation. Saline vaccines will therefore be used as a routine and lipovaccines will be reserved for emergencies.

* * * * * * *

LOCAL AND SYSTEMIC REACTION FOLLOWING PROPHYLATIC VACCINATION

There is nothing to indicate that any permanent disability followed the vaccination of troops during the war. Furthermore, the temporary disability produced by the triple typhoid vaccine was not great. Of the approximately 4,000,000 men who were mobilized for our war Army, all of whom were inoculated with typhoid vaccine soon after enlistment, only 35,552 were admitted to sick report for reactions following vaccination.

Foster, working at Camp Meade, Md., made an exhaustive study, from the clinical point of view, of the effects of triple typhoid vaccine on a large number of troops in that camp and reported as follows on the unusual reactions to typhoid and paratyphoid vaccination:[43]

The reaction which is usually experienced from prophylactic doses of typhoid vaccines amounts only to a slight discomfort. At worst the subject is seldom more uncomfortable than he would be with an acute tonsilitis, and he has the consolation that 18 to 24 hours will mark the termination of the symptoms. There seems to be a consensus of opinion, however, that vaccination with the mixed typhoid-paratyphoid culture is not so apt to be passed unnoted as vaccination with the single typhoid strain. The symptoms commonly varying somewhat in degree, are slight fever, chilliness, muscular pains and backache; not so usual, but still relatively frequent, are severe headache, vomiting or diarrhea, or both, epistaxis, and bronchitis, which last may continue for days or even a couple of weeks. This list includes all the symptoms which occur in the average cases, and from these deviations are not unusual. Occasionally, of course, bizarre cases are noted due, perhaps, to some accident in technic.

Differentiated from the above-mentioned majority, of over 40,000 vaccinated troops, was found a group of cases, admitted to the wards of the base hospital at Camp Meade on account of rather severe symptoms. These symptoms at least suggested certain specific diseases. On account of the diseases simulated this group may be subdivided into meningeal, appendiceal, and purpuric types. These cases were sufficiently frequent to afford opportunity for study, and because of the diagnostic embarrassment which we experienced in the beginning no little attention was given to them. The reaction which bore resemblance to appendicitis was most common. At least 50 of these cases were studied, and of the other types a somewhat smaller number.

The meningeal type of reaction is alarming because of the resemblance to meningitis. When, as happened with two cases, there were in addition to other signs a few fine purpuric spots on the body, the resemblance to an early stage of "spotted fever" was complete. The usual course of events with my cases was initiated by headache, commencing a few hours after vaccination and gradually increasing to an almost unbearable intensity. With severe headache photophobia is the rule. There was pyrexia up to 102° F. and sometimes vomiting. When put in bed the patient assumes the meningitis posture—lying on the side, knees up, and head thrown a little back. On examination one finds invariably with these cases some stiffness of the neck, a positive Kernig sign, and a mild hyperæsthesia. In the absence of history, diagnosis can hardly be made without lumbar puncture. When lumbar puncture is done the cerebro-spinal fluid is found under considerable increase of pressure, often dropping too fast to be counted. The fluid is clear and normal. There is no significant cell increase. Withdrawing 10–15 c. c. of fluid almost invariably relieves the headache. In brief, the condition is one of meningismus.

The appendicitis picture is definite enough as a clinical picture with localized pain and tenderness, slight fever, and some increase in the leucocyte count (due to vaccine). A number of these cases were operated upon. The appendices removed, however, did not present the conditions expected, and an agreement between the surgeon and the pathologist on this point was impressive. With this experience a conservative attitude developed and none of the cases of this type was operated upon. At a somewhat later period, while at General Hospital No. 14, I found that Lieut. Col. Edward Martin had become interested in the surgical aspect of this problem but had come to a different conclusion in that with his cases the appendix did show more evidence of acute inflammatory change. Colonel Martin's cases gave a history suggesting repeated attacks of appendicitis in the past, and it has been proposed in explanation that the vaccination excited an acute process in an indivisual thus predisposed. Neither the immediate practical question involved nor the underlying one of scientific principle can be clarified by evidence now available. It will be recalled that shortly after typhoid vaccination began to be somewhat extensively used among our civil population in the cities the statement was made and repeated that latent tuberculous foci in the lungs might be thus fanned into activity. Some scattered attempts were made to ascertain the truth, but these studies bear analysis as badly as the statements to be examined. At present there are opinions, but little evidence. Similar opinions are current as to the effects of vaccination on latent chronic urethritis, arthritis, and some other conditions. The whole subject requires careful reexamination. It is of interest in passing to recall that vaccines made from typhoid cultures have been advocated for the treatment of some of these conditions—arthritis, urethritis—which we are now assured are aroused into activity by the same measure.

There is so much obscurity surrounding the etiology of purpura that the cases following vaccination had for me an especial interest. The first of these cases to receive recognition was admitted from a regimental infirmary on account of epistaxis. * * * On the morning of admission to hospital he had epistaxis, and for this reported at sick call. The epistaxis was obstinate and required "packing." Examination showed a purpuric eruption covering the body. The spots were small and discrete, varying from one-sixteenth inch to one-eighth inch, and purplish in color. There was no bleeding of the gums; no blood found in urine or feces. We had not at this time facilities for exact measurement of clotting time, but no abnormality was noted by means of improvised apparatus. The bleeding time and cell counts were normal. The rash gradually faded to a tawny brown stain, and the patient was returned to duty.

On inquiry, stimulated by this case, it was found that a number of cases had been admitted to the otology service of the hospital because of epistaxis following vaccination, and it was recognized that many of these had hematuria and a few had purpuric eruptions. A number of cases of varying degrees were studied subsequently in both these services. Epistaxis with transient hematuria was not uncommon. Some of these showed also hemorrhages and purpuric rashes. In one case there was violent epistaxis, hematuria, melena, and extensive purpura and hemorrhage into some of the joints. The left elbow had later to be opened and the clot removed. All of these cases made perfect recoveries.

Since an understanding of this condition would be helpful for an understanding of purpura, examinations were made of blood in respect to the clotting and bleeding times, cell counts, and platelet counts. So much normal variation was found in the platelets that no evidence could be recured in this direction. The other estimations were normal, except a slight leucocytosis observed in many cases after vaccination without special symptoms.

Statistical tables of the Surgeon General's Office for the World War period show that five soldiers were discharged from the Army for disability following triple typhoid vaccination. A further investigation of the clinical records of these cases, however, revealed an error in tabulation; although some temporary disability resulted from vaccination, a careful search of the records failed to reveal any cases that terminated in permanent disability or death.

The use of typhoid vaccine as a protective measure having been a routine procedure in the United States for a number of years prior to the World War, the American military authorities appreciated the fact that the reactions following its administration not infrequently (approximately 10 per cent) were moderately severe during a period of from 24 to 48 hours after inoculation. For this reason it was the custom to recommend that all personnel be excused from all duties, except the necessary roll calls, for a period of 24 hours after vaccination. The experience gained in the vaccination of 4,000,000 men during the World War further confirms the wisdom of carrying this procedure into effect, and it is now required by Army Regulations.

FACTORS THAT MAY BE RESPONSIBLE FOR THE OCCURRENCE OF TYPHOID IN INDIVIDUALS PRESUMABLY PROTECTED BY VACCINATION

As noted, a large proportion of the cases of typhoid in troops in the large mobilization camps in the United States occurred in individuals who had not been protected by prophylactic vaccines. Approximately 885 cases occurred in approximately 1,900,000 men serving in France, and it is highly improbable that any appreciable number of these men were uninoculated. Vaughan,[3] in a careful study of the records of 270 cases of proven typhoid in France, found that all had received prophylactic inoculations, and that in 207 of the 270 cases there was a record of the dates of vaccination and types of vaccine used. Why did prophylactic vaccination occasionally fail to protect against typhoid? Concerning this matter we have no definite information. Vaughan, who gave it considerable attention, made the following comments on this phase of the problem:[3]

1. *Absence of vaccination, either total or partial.*—By this I refer to failure not because of impotent vaccine but because of failure to react in certain individuals. It is well known that after the same doses of vaccine different persons form different amounts of agglutinins. But agglutinin titer is not a measure of immunity. We have no criterion that will tell

us when an individual is actually immunized, nor have we any means of determining the degree of immunity present.

2. *New strains of the organisms against which the vaccine does not immunize.*—Serologic and cultural determinations made in the various laboratories have not consistently produced anything to suggest such a condition.

3. *Failure of proper inoculation.*—Among the cases of true typhoid studied, vaccination had been performed in 50 different camps and posts in the United States. This fact, combined with the really excellent results in most individuals vaccinated, renders such a possibility rather remote.

4. *An overwhelming dose of the infecting organism.*—Absolute immunity to human disease does not exist in man. The highest immunity that can be produced by artificial methods will protect against the antigenic virus only up to a certain limit. I am of the opinion that the greater number of cases of typhoid and paratyphoid in France occurred as a result of massive infection with a dose great enough to overwhelm the forces of immunity. This, I presume, was most frequently associated also with the first cause enumerated, "absence of vaccination, either total or partial," in that it occurred in those possessing a lower degree of immunity than their more fortunate comrades. As Bernard has so succinctly expressed it, vaccination raises against the typhoid bacillus a great barrier—high, but not insurmountable.

5. *"Back-handed typhoid," "antibody exhaustion," or "immunity exhaustion."*—I include the second designation of this condition as being the most readily comprehensible in view of the existing nomenclature and conceptions of immunity, while I prefer the third as being more scientifically correct. I developed the first term as I recognized more and more of this type in the field, and it has the particular advantage that it emphasizes the assumption that the successive stages of typhoid infection are therein, in a manner, reversed.

The present-day conception of typhoid is that it is of primary systemic infection. The organisms entering by way of the gastrointestinal tract are absorbed into the circulation and do not primarily grow as saprophytes in the alimentary canal. After passing through the gastrointestinal mucosa, the organisms reach the liver through the portal circulation, where they may be excreted through the bile; or some may pass into the general circulation, where they multiply and, after the usual period of incubation, cause typhoid fever. The organism excreted in the bile may lodge in the gall bladder and there, growing, produce the carrier condition, even though the host has not had typhoid fever.

In a vaccinated person, the organisms entering the portal circulation are either broken up and destroyed by the body ferments or excreted into the bile, or both. In the gall bladder they may find lodgment and continue to grow, in reality outside the body organism, multiplying profusely even though the host be highly immune. The number of organisms that are continually discharged in the bile and resorbed through the intestinal mucosa call on the immunity mechanism for constant and exhausting action. There may be superimposed on this local enteritis caused by one of the typhoid-colon group or any other organism, or even by the typhoid member of the group itself. This subacute or chronic condition rendering toxic absorption more facile, serves gradually to undermine the constitution. Finally, added to all this, are the hardships of war and army life—exposure, food not always well balanced, fatigue, and perhaps at last some intercurrent infection—and all the conditions required to wear out a body immunity are then present.

It is this reversed process—a local infection or carrier state followed by systemic disease instead of the usual typhoid followed by a carrier condition—that I have chosen to call "back-handed typhoid." Overwhelming doses of the infecting organism and this exhaustion reaction were in my opinion two of the chief causes of typhoid among our troops.

From the nature of the condition it has been impossible to obtain convincing experimental evidence of its presence in France; but a certain amount of indirect evidence appears to warrant our assuming its presence. Our first case occurred in a colleague who, preceding his illness, had been billeted with a French family and who had been drinking unchlorinated water while at his billet. For two weeks or more he had been complaining of general malaise and a moderate diarrhea, but not sufficient to keep him from his work. At the end of two or three weeks the illness became acute, the usual symptoms of typhoid developed, he became progressively worse, and he died within one week from the onset of the exacerbation.

These cases present the usual clinical histories of ambulatory typhoid, with the definite addition of a local gastrointestinal pathologic condition and symptoms preceding the disease proper. Otherwise there is nothing unusual about the symptomatology. Especially frequent was this syndrome among the men who had seen active service at the front. From nearly all, a history was obtained of having drunk whatever water they could get, even from the stagnant mud of the shell holes.

To check up on the impression I had gained, I questioned 104 patients as to previous history of chronic local gastrointestinal disturbance. All were straight typhoid cases. Forty-four denied attacks of diarrhea antedating the diarrhea of the disease itself. Thirty-nine admitted a continuous preceding enteritis varying from one week to three months in duration, and of these, 23 had it for over a month. Fifteen had had diarrhea for from one week to three months while at the front, which had subsided and from which they had been free for from two to three months. Seven additional patients admitted having had a transient diarrhea of from one to five weeks duration in the two months preceding their disease.

Subacute diarrhea is not a necessary, or the usual, antecedent of typhoid fever. The disease begins frequently even with constipation. I would compare the foregoing figures, in which more than 60 per cent had been afflicted with enteritis, with the statements of the Typhoid Commission in the Spanish-American War, that in that epidemic "More than 90 per cent of the men who developed typhoid fever had no preceding intestinal disorder." I do not believe that the figure of 60 per cent would hold for all men attacked by this malady in the American Expeditionary Forces, but do assert that it was the case in a representative number of those who had been at the front.

There is no proof that these men were harboring the typhoid bacillus in their intestinal tract previous to coming down with the disease. It is here that my hypothesis fails of absolute proof. Such proof would have necessitated a survey of the stools of all members of a division, to be followed by weeks or months of watching to see whether the carriers discovered would develop the disease. Moveover, had this been done, the carriers would have been hospitalized and treated, thus defeating the object of the experiment. But corroborative evidence is not lacking. Several observers have reported the finding of typhoid bacilli in the stools of patients a few days or more previous to the onset of the disease, while Battlehner has reported four cases in whose excreta the bacilli were discovered from 21 to 117 days before the onset of the disease. These had been considered as healthy carriers. I have a record of one patient who one and a half months previous to admission cared for a typhoid patient and shortly thereafter developed diarrhea, which persisted for six weeks until the typical acute onset of typhoid. In the discussion of typhoid carriers I have called attention to 10 out of the 32 carriers, with history of diarrhea, none of whom had had preceding typhoid, and one carrier with no history of typhoid and no diarrhea, who nine months previously, at Camp Dodge, had had negative stools for the typhoid group.

I have shown, then, that carriers have been produced in France; that diarrhea is often associated with the carrier condition; that among 104 men, diarrhea preceded the disease in 60 per cent; that in one instance exposure to the disease was followed by enteritis which persisted for six weeks, until the onset of typhoid. Before absolute proof of back-handed typhoid is produced, I must show that all these facts find sequence in individual cases.

6. *Unsatisfactory vaccine, either as regards antigenic properties or number of doses administered.*—Considerable experimental evidence has accumulated to show that with increasing numbers of inoculations the immunity increases. Four inoculations confer a greater degree of immunity than do three. One of the advantages of the method in use in the United States Army is that the men nearly all receive the same vaccine in the same dosage and with the same number of inoculations. Observers in other armies were sometimes forced to draw their conclusions from patients who had received different kinds of vaccine and all numbers of injections, from one to four or more. The fact that our vaccine did protect in the great majority of the cases demonstrates the efficiency of our preparation and of the dosage. It may not be ideal, but it is thoroughly practical.

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CLINICAL COURSE OF TYPHOID FEVER IN THE VACCINATED INDIVIDUAL

The general impression prevailed at the outbreak of the World War that the clinical manifestations of typhoid fever in the vaccinated individual differed from those found in the unvaccinated. The statement is made by Gay [44] that not only is the mortality rate decreased but the disease itself is found to undergo a very distinct modification when it occurs in the vaccinated individual, so much so, that it frequently is so mild as to offer great difficulty in diagnosis. Vaughan, in a study of a series of 373 cases occurring in vaccinated individuals in the American Expeditionary Forces, France,[3] found that the most striking feature of the disease in the inoculated was its almost classical resemblance to the old typhoid fever as one knew it in the unvaccinated individual. Not only was this resemblance noted in the clinical history but also at the bedside. In the majority of cases in which the typhoid bacillus was isolated there was no difficulty in the clinical diagnosis. Typhoid facies, coated tongue, rose spots, palpable spleen, rigid and slightly tender abdomen, and dicrotic pulse were the rule rather than the exception; however, as in the uninoculated, all gradations of the disease were found. One has long been acquainted with mild and ambulatory cases, with difficulty in diagnosis on account of the mildness of the disease, and frequent absence of many of the usual symptoms of typical typhoid fever. Many such cases probably occurred among our troops in France and remained undiagnosed. It is further possible that the number of cases that would fall under this class had been greatly increased by previous inoculation. But of those patients whom we have seen sick in hospital there could be no doubt as to the clinical diagnosis.[3]

Leucopenia was not as marked as in the classical typhoid fever. The average white count on successive days was about 7,000. In a few cases from 2,000 to 4,000 white cells per cubic millimeter were noted. The above average agrees with the report by Hawn, Hopkins, and Meader.[14] The average white count during hemorrhage was 4,500; in perforation, 6,000; in lobar pneumonia complicating the disease, 12,000, and in bronchopneumonia 9,000. These figures, however, agree with those occurring in typhoid fever in the unvaccinated.[3]

What has been said relative to the white blood count applies to the febrile course of the disease; that is, the type of fever in vaccinated patients did not differ remarkably from that in unvaccinated. The average day of cessation of fever was 26.9; relapse occurred in 10 per cent of the cases and the average date of onset was the 35th day. Death occurred in 11 per cent of 270 of the cases studied and the 21st day was the average day of death.

The foregoing clinical findings are in accord with those reported by other observers. Labbé [45] remarks that the symptomatology has nothing characteristic and the same elements are present and appear in the same order among vaccinated and unvaccinated individuals. The onset is not marked by special symptoms and during the fastigium, diarrhea has the usual occurrence. However, it may be that this symptom occurs somewhat less frequently in the vaccinated. Bernard and Paraf,[46] in describing the clinical symptomatology among French troops, remarked that typhoid fever among the vaccinated has no particular characteristic which might indicate a modification of the disease.

The different classical forms are seen with their usual characteristics. Campani and Gallotti[47] reported that in a series of cases of typhoid and paratyphoid fevers occurring in 144 nonvaccinated civilians and 341 vaccinated soldiers on the Italian front the case mortality rate from typhoid fever in the vaccinated patients was 8.6 per cent and in the paratyphoid A and B cases 4.6 and 7.8 per cent, respectively. Among the unvaccinated the case death rate for typhoid was 20 per cent and for the paratyphoid cases nil. They found that in both groups about 42 per cent of the patients had a febrile period lasting into the fourth week and that the average duration of fever was, among the soldiers, 24.5 days and among civilians 28 days. They state that the febrile curve instead of being irregular and low in the vaccinated, was high and decidedly more regular than among the nonvaccinated. Splenomegaly and nervous phenomena were more frequent among the vaccinated. These workers concluded that vaccination had lessened both the mortality and the severity of the disease.

Freund[48] reported typhoid infection in the German Army and concludes that among the vaccinated cases there were more remissions and intermissions as well as a great number of mild cases. The fever was milder but the total duration of the disease was not shortened. No change in the frequency of the complications or relapses resulted on vaccination, and mortality given among the vaccinated was 8.3 per cent.

Hawn, Hopkins, and Meader,[14] in describing the 38 cases studied in an outbreak among American troops in England, found clinical symptoms similar to the cases described by Vaughan. The initial chill occurred in 16 per cent, diarrhea in 58 per cent, constipation in 21 per cent, abdominal pain in 6 per cent, and epistaxis in 2.6 per cent. Rose spots were described in 19 cases, splenomegaly in 9 per cent. Blood cultures were positive in 12 cases and the mortality was 13.15 per cent.

There was a somewhat progressive increase in severity with lapse of time after inoculation in individuals to whom vaccine had been administered from one to six months before the patient was taken sick (11.6 per cent severity). When from 13 to 18 months had elapsed, 15.9 per cent were classified as severe. It appeared that the average severity of the disease was fairly constant throughout the first eight months following inoculation, after which it gradually increased. The proportion with relapse did not appreciably differ.

COMPLICATIONS, SEQUELÆ, AND CONCURRENT DISEASES

The complications and sequelæ of typhoid fever during the war afforded nothing new from either a clinical or pathological point of view. Among the more important of these were 4 cases of general septicemia, with 4 deaths; 2 cases of acute endocarditis, with 2 deaths; and 7 cases of myocardial insufficiency, of which 2 resulted fatally. Important complications of the respiratory tract were 26 cases of bronchitis, with 6 deaths; 59 cases of bronchopneumonia, with 39 deaths; 29 cases of pneumonia, of which 24 terminated fatally; and 18 cases of pleurisy, with 6 deaths. Hemorrhage was recorded in 11 instances, with 8 deaths; and diarrhea as a complication in 5 cases, of which 3 terminated fatally. Enteritis and colitis occurred in 12 instances, with 2 deaths; and peritonitis in 8, with 7 deaths. There were 2 deaths among the 4 cases of acute

nephritis. Altogether 209 complications were deemed as being of sufficient importance to be reported, with 151 deaths.

Typhoid fever was reported as concurrent with other diseases in 368 instances. Of these, 60 terminated fatally, giving a case mortality of 16 per cent. The more important diseases with which it was concurrent are given in Table 8.

TABLE 8.—*Typhoid Fever. Concurrent with other diseases, enlisted men, United States Army, serving in the United States and Europe, April 1, 1917, to December 31, 1919*

Primary cause of admission	Absolute numbers	Deaths	Case mortality	Primary cause of admission	Absolute numbers	Deaths	Case mortality
Influenza	162	33	20.37	Enteritis and colitis	25	4	16.00
Tuberculosis of the lungs	4	3	75.00	Intestines, other diseases of	5	2	40.00
Bronchitis	29	1	3.45	All others	98	6	6.12
Pneumonia, broncho-	29	6	20.69				
Pneumonia, lobar	16	5	31.25	Total associated	368	60	16.30

CARRIERS

Nichols,[49] who made a somewhat exhaustive study of the "carrier" state during the World War, classified carriers as "incubationary," "convalescent," and "contact." The percentage of cases that develop the carrier state of one class or another has been variously estimated as being from 9 to 50 per cent, women constituting the majority, three-fourths of the carriers being of the intestinal type.

The bacteriological examination of the stools and urine of food handlers at stated intervals, and examination of convalescents from typhoid for the carrier state prior to their discharge from hospital, was a matter of routine during the World War, and by means of this administrative procedure a few carriers were detected. According to Nichols, the results of examination of about 30,000 food handlers during the war demonstrated less than 0.1 per cent carriers among healthy males. Gay [44] states that 7,500 carriers are being added to the civilian population in the United States each year. There were 64 recorded carriers among the primary admissions to hospital during the war.

Instructions governing medical officers, A. E. F., in the determination of a carrier state were as follows:[50]

* * * * * * *

Typhoid and paratyphoid patients excrete the bacilli, frequently with their urine and practically always in their feces. This is most likely to occur during the third and fourth week of the disease, the condition may persist throughout convalescence and not infrequently longer. It is, therefore, important not to release the convalescent typhoid or paratyphoid fever patient until he ceases to excrete these bacilli.

Three negative cultures of the urine and feces at six-day intervals should be required before release of patient, the first not earlier than one week after temperature curve has become normal.

Some persons who have never had a clinical history of the disease may excrete typhoid or paratyphoid bacilli. It is important to detect such carriers in any occupation, but especially among cooks and handlers of foodstuffs. In such a carrier survey, two examinations should be done on each individual.

No definite lesions were found in incubationary and contact carriers. The liver and kidney showed lesions in convalescent carriers. In intestinal carriers with lesions in the gall-bladder, bile-ducts, or both, the organism was demonstrable in the stools. In urinary carriers the focus was found in the kidney, especially in the pelvis.

According to Nichols,[49] carrier strains did not differ from others and could not be differentiated by cultural or other tests. In determining the carrier state serological examinations were suggestive, as more than 50 per cent gave positive agglutination tests. Such examinations, however, were of little value in the case of convalescents from the disease or in the recently vaccinated subject. The organism was found in the duodenal contents or feces in the intestinal type of carriers and in the urine in urinary carriers. It was the custom to require at least three consecutive examinations of the feces and urine of convalescents from typhoid before dismissing the possibility of an existing carrier state.

In the United States it was the policy to collect all chronic typhoid carriers in the Army at the Walter Reed General Hospital, Washington, D. C., for further observation and treatment.[51] At the time the armistice went into effect arrangements also had been completed for the establishment of a special hospital in France, near Dijon, for the treatment and study of chronic "carriers" of all types in the American Expeditionary Forces.

An essential in the successful treatment of typhoid carriers was location of the focus of infection which, though usually single, sometimes was multiple. Where the focus was a single one, as for example, the gall-bladder, treatment by excision usually effected a cure. Where the foci were multiple, as for example in the gall-bladder and in the bile-ducts, removal of the gall-bladder did not result in a cure.

Nichols, Simmons, and Stimmel [52] reported on the surgical treatment of typhoid carriers at the Walter Reed General Hospital in 1919. Seven cases are included in this report; 6 were intestinal carriers and 1 urinary. Four of the former were cured by removing the infected gall-bladder, and the urinary carrier was cured by removal of the infected kidney. In two of the intestinal carriers failure was attributed to the gall-duct being infected as shown by cultures of the duodenal contents. Operation was not recommended for at least six months after recovery from the primary disease, as in many instances the carrier state was of temporary duration. Henes[53] reported favorably upon the surgical treatment of typhoid bacillus carriers at the United States Army General Hospital No. 12 during the war.

In spite of all known methods of treatment, some chronic carriers continued to excrete bacilli. The commanding officer of the Walter Reed General Hospital reported several such cases to the Surgeon General in April, 1919.[54] These cases had been operated upon, but foci of infection remained. The procedure followed in such instances was to discharge the individual from the Army, at the same time notifying the State board of health having jurisdiction.[55]

DIAGNOSIS

For many years, particularly since prophylactic vaccination was made mandatory, the Medical Department of the Army has stressed the importance of the scientific and early diagnosis of typhoid fever. Before we entered the World War it was required that the diagnosis be based on isolation of the organism and that a culture of the isolated organism be sent to the Army Medical School at Washington for confirmation. This practice was continued during the World War except that organisms isolated in France were sent for confirmation to the central medical department laboratory at Dijon.

A prompt report of cases of enteric fevers was insisted upon by the chief surgeon, A. E. F.[56] For purposes of classification a division was made into proven cases, clinical cases, suspects, convalescents, and healthy carriers. Diagnoses were reported by telegram to the chief surgeon, A. E. F. With the development in France of several foci of infection—December, 1918, and January, 1919—the chief surgeon, A. E. F., issued a special circular letter relating to the typhoid and paratyphoid fevers. The following notes on diagnosis were incorporated in this letter:[50]

In individuals previously vaccinated against typhoid but who have completely lost their immunity, infection similar to that found in the unvaccinated occurs, giving rise to the symptom complex * * * characteristic of typhoid fever.

Infections occurring in the vaccinated individuals who still possess a certain degree of resistance to infection results in the appearance of atypical clinical pictures, such as abortive types of typhoid and paratyphoid in which the constitutional symptoms are mild but with slight febrile reaction of atypical type and few if any rose spots. The onset may be either insidious, with headache, loss of appetite, and fatigue, or acute and associated with chills, vomiting, intestinal cramps, and diarrhea. Fever may be wholly absent or evanescent in character and determined only if observations are made within the first 48 to 72 hours. A low type of temperature, with daily fluctuations of from 98.6° to 100.4°, suggestive of the presence of tuberculous disease, may persist for a week or 10 days. It is in this class of cases that blood cultures taken early in the course of the disease, and repeated if negative, frequently give definite information concerning the nature of the infection. Ambulatory types of typhoid are not uncommon and the first indication of the existence of the disease may be furnished by the occurrence of intestinal hemorrhage or perforation.

The vaccinated individual protected against general systemic infection may still act as a carrier of typhoid infection and frequently shows clinical manifestations of local disease of some portion of the gastrointestinal tract, while the characteristic symptom complex of typhoid fever due to general infection, namely, continued fever, rose spots, and enlarged spleen, may be wholly absent. * * *

Atypical modes of onset.—(*a*) Acute onset with symptoms simulating meningitis. Lumbar puncture differentiates. (*b*) Acute onset with intense, usually generalized bronchitis or symptoms suggestive of lobar or bronchopneumonia. (*c*) With chills, fever, vomiting, cramplike pain in abdomen, sometimes localized in right iliac fossa and suggesting appendicitis. (*d*) With symptoms of acute nephritis. Attack begins suddenly, with nausea, vomiting, pain in lumbar region, diminution in secretion of urine, which is highly colored and contains albumin and casts. (*e*) Special mention should be made of the ambulatory type of typhoid in which the symptoms are slight, consisting simply of headache and lassitude associated with mild gastrointestinal disturbances. The patient is at no time confined to his bed, and intestinal hemorrhage or perforation may furnish the first clue with regard to the existence of typhoid. (*f*) In the above atypical modes of onset early blood cultures are of importances in differentiation. * * *

In the differential diagnosis influenza, acute miliary tuberculosis, sepsis, and malarial fevers must be differentiated. Local and unexplained gastrointestinal derangements, as

gastritis, diarrhea, dysentery, enteritis, appendicitis, and inflammation of the bile passages, occurring with or without fever should be regarded with suspicion when cases are admitted from commands in which cases of typhoid or paratyphoid fever have occurred.

Laboratory diagnosis of typhoid and paratyphoid fevers.—Bacteriological procedures are of great value (1) for the certain and early diagnosis of suspected cases; (2) to determine carrier state in convalescent positive cases; (3) to detect carriers in otherwise normal individuals.

Blood cultures offer the most certain method for early diagnosis of undetermined fevers, and it should be kept in mind that the earlier in the disease the blood culture is taken the more likely is the result to be positive; thus, in positive typhoid fever the chance of successful blood culture declines from 90 per cent during the first week to 40 per cent during the third week. In paratyphoid A fever, because of the frequently short and mild febrile period, the prompt and early blood culture is all the more necessary. Relapses are more common in paratyphoid than in typhoid, and taken at such a time, blood culture yields positive results in every case.

The following method of blood culture is recommended as being suitable in all cases of fever of undetermined etiology.

(*a*) When laboratory facilities are at hand, take 10 c. c. of blood from a vein at the elbow. Place 3 c. c. in each of two flasks containing 100 c. c. of plain broth. Place 1 c. c. in tube of agar (melted and cooled to 45° C.); immediately mix and pour plate. Place remainder of blood in dry sterile test tube to separate serum for such serological tests as may be suggested.

The two flasks and plate are incubated and examined the following day. Transplants are made to plain agar slants, or, better, Russell's double sugar agar. In cases of development of Gram-negative motile bacilli on agar slants, emulsions should be made and agglutination tests done with immune sera for final identification.

Frequency of nonagglutinability of recently isolated typhoid cultures should be kept in mind. Negative blood culture in suspected typhoid fever means little. Repeat if clinical conditions indicate.

(*a*) If the blood culture specimen can not be taken directly to the laboratory, filtered sterile ox bile is most useful, 5 c. c. in a tube. To such sterile ox bile 5 c. c. of blood is added, the tube closed with a sterile paraffin cork, carefully packed, and sent for examination to the nearest laboratory. Bile medium is furnished in chest No. 1, transportable laboratory, United States Army, expeditionary force model. Additional supply of this medium may be obtained as needed from central Medical Department laboratory, A. P. O. 721.

Bacteriological examination of feces is second only to blood culture as an important means of positive diagnosis. It is especially important in paratyphoid B fever. * * *

The Widal test—In view of previous vaccination with T. A. B., vaccine has been generally held of little or no value; however, it should be stated that the determination of agglutinin titer of patient's serum at intervals of one week and the demonstration of progressive and marked increase of agglutinin content of the blood offer, especially in the absence of positive blood culture, excellent evidence as to the etiology of the disease. Thus, in typhoid fever an agglutinin titer (Widal test) of 1 to 40 during the first week of the disease may advance to 1 to 1280 during convalescence. In paratyphoid B fever the titer frequently advances to 1 to 2,560; however, in paratyphoid A fever it may not reach 1 to 640. Formalinized and standardized bacterial suspensions of *B. typhosus B*, *paratyphosus A* and *B*, *paratyphosus B* may be obtained on request from the central Medical Department laboratory, A. P. O. 721.

In the series of cases studied by Vaughan,[3] blood cultures were made from 274 cases and typhoid or paratyphoid bacilli were isolated in 180 cases, or 65.7 per cent. Of these 180 positive results, 143 were positive on the first culture, 25 on the second culture, 3 on the third, 9 on the fourth, and none on the fifth, showing the value of repeated culturing. In the case of the epidemic occurring in the Camp Cody replacement unit, 32 per cent of the blood cultures taken in England were positive and 88 per cent of those taken at Cherbourg; in the Prauthoy epidemic 16 per cent were positive; in the Curel epidemic 88 per cent; and in the Marseille epidemic 28 per cent were positive. This is a

very wide range of positive cultures and indicates, in the low percentages, either delay in resort to laboratory diagnosis or lack of skill on the part of the laboratory personnel. A blood culture is manifestly of much greater value than a stool or urine culture. In the Curel epidemic, which was handled promptly by a skilled laboratory force, the per cent of positive blood cultures was high (88 per cent); consequently, it was necessary to resort to cultures of the urine and stools and there were reported only 14 per cent positive feces and 3 per cent positive urine. In the case of the Marseille epidemic with a low percentage of positive blood cultures the gravity of the situation was not at first appreciated. The local laboratory personnel was reinforced and subsequently there were reported 53 per cent positive stool and 14 per cent positive urine culture. Likewise in the Nevers epidemic and for the same reason there were but 15 per cent positive blood and 38 per cent positive stool and 31 per cent positive urine cultures.

Marris,[57] of the British Army, during the course of an extended study of typhoid patients, developed the so-called atropin diagnostic test. He held that when the human body is so invaded by bacilli of the typhoid group as to exhibit typhoid, paratyphoid A, or paratyphoid B fever, a toxin is formed which effects the heart in a peculiar manner; the presence of this toxin can be detected by observing the abnormal yet characteristic reactions of such hearts to a certain drug, notably atropin. This reaction consists in the failure of acceleration of the pulse beat more than 15 beats per minute after the hypodermic injection of a large dose (one thirty-third gram) of atropin. Marris based his observations on 111 cases of proved typhoid or paratyphoid. The test was positive in 92 per cent of cases in the first week of the disease; 89 per cent in the second week; 83.7 per cent in the third week; 88 per cent in the fourth, and in the later stages the reaction was not characteristic. He found the test to be negative in the case of typhoid carriers and in a list of other diseases such as trench fever, meningitis, bronchitis, pneumonia, tuberculosis, dysentery, malaria, influenza, etc. The same results were noticed with amyl nitrate and adrenalin as with atropin.

In Vaughan's[3] series the atropin test was made in a small number of cases and was usually found to be positive, more markedly so during the first week, when the pulse was slow. It was often negative after the pulse rate increased. In 38 cases reported from England[14] an acceleration of pulse rate occurred in 33 cases, a decrease of rate occurred in 1, and no alteration in 2 cases. Of the 33 showing acceleration, 23 showed a positive reaction. The earliest day on which the test was performed in this positive group of 23 cases was the seventeenth day; the latest the thirty-first day. The positive reaction for the group was 68 per cent. Of the 10 cases showing a negative reaction, the test was performed after the twenty-first day of the disease—seven of them being after the thirtieth day of the disease. If the seven cases occurring in the later stages of the disease, when the reaction is not supposed to be characteristic, are eliminated, the result would stand, as 81.5 per cent positive tests. Friedlander and McCord,[58] at Camp Sherman, Ohio, tested the effect of atropin in other diseases than typhoid and found that in 170 cases, 62, or 36.5 per cent, gave a positive reaction. Their list of diseases included measles, influenza, scarlet

fever, and pneumonia. These investigators are of the opinion that a test which gives such a high percentage of positive results in other diseases than typhoid can not be depended on.

The statement is justified that the Widal reaction is of somewhat doubtful value in the diagnosis of typhoid fever in the recently vaccinated. This contention is supported by Hamilton[59] and Fennel.[60] Dreyer, Walker and Gibson,[61] and Davison[62] present arguments in support of their opinion that microscopic Widal tests, with a standardized agglutinable culture, made at intervals, to demonstrate fluctuations upward or downward, in agglutinin content, have a definite diagnostic value. It may be stated that agglutination tests in the vaccinated, while suggestive of the presence or absence of specific infection, can not replace in diagnostic value the recovery of the specific organism from the blood, urine, feces, or bile. The agglutination reactions performed in the Army followed the Dreyer technique closely.[63]

In Vaughan's[3] series of 206 cases, in which the tentative or provisional diagnosis was noted, 120 bore a diagnosis of respiratory disease, while only 49 were diagnosed as gastrointestinal. This is in accordance with previous knowledge of the disease, the initial symptoms being not local but the general symptoms of acute infection frequently with a concomitant bronchitis. The pandemic of influenza prevailing at the time also tended to render difficult a proper diagnosis.

Vaughan's report that the onset was generally gradual and misleading is confirmed by a study of the period elapsing between onset and hospitalization. In the 123 cases occurring in the 77th Division, the cases were hospitalized on an average of 8.1 days after the onset of the disease, the extremes being 1 to 57 days. The laboratory diagnosis was made on an average of 19.6 days after the onset, the extreme being 7 and 60 days. This gives an average of 11.5 days spent by a case in the hospital before a laboratory diagnosis was made. In the 38 cases occurring in England (infected in the United States en route to England) the average date on which the cases were hospitalized was 13½ days after initial symptoms; in the Prauthoy epidemic it was 52.5 days.

THE PARATYPHOID FEVERS

Recognition of the paratyphoid group of fevers (A and B) as disease entities is a fairly recent development of scientific medicine, antedating the World War by only a few years. The experience of the Medical Department of the United States Army with this group of fevers prior to the World War was limited very largely to a sharp outbreak of paratyphoid fever A in National Guard troops on active duty on the Mexican border of Texas during 1916 and the early part of 1917, and an outbreak of paratyphoid A that occurred in the expeditionary force of the Regular Army dispatched into Mexico during the summer of 1916.[38] These epidemics were very quickly brought to an end by the use of paratyphoid A vaccine. As paratyphoid fevers were being reported as of not uncommon occurrence in all allied armies in France when the United States entered the war, steps were immediately taken to incorporate the paratyphoid A and B organisms in prophylactic vaccines to be used by the American Army. This group of fevers was a negligible factor as a cause of illness in the United States Army, as is indicated in Table 9.

TABLE 9.—*Paratyphoid fevers. Officers and enlisted men, April 1, 1917, to December 31, 1919, by country of occurrence, admissions, and deaths. Absolute numbers and rate per 1,000 per annum*

Country	Total mean annual strengths	Para A				Para B			
		Admissions		Deaths		Admissions		Deaths	
		Absolute numbers	Rate per 1,000	Absolute numbers	Rate per 1,000	Absolute numbers	Rate per 1,000	Absolute numbers	Rate per 1,000
United States	2,235,389	32	0.01			11	0	1	0
Europe	1,665,796	95	.06	6	0	56	.03	4	0
Other countries	227,294	7	.03			11	.05		
Total primary cases	4,128,479	134	.03	6	0	78	.02	5	0
Additional cases as associated diseases		41		5		17		1	
Grand total		175		11		95		6	

The death rate for cases occurring in the United States is the more reliable one. Most, if not all, of the deaths from paratyphoid recorded for troops in Europe actually were due to causes other than paratyphoid, but were charged back to the paratyphoids for the reasons stated elsewhere (p. 15).

The clinical characteristics of the paratyphoid fevers as they occurred in American troops during the World War can be summarized as follows: On the whole, the disease followed a much milder course than did typhoid. The individual case could not be distinguished from typhoid fever by clinical manifestations alone. Both diarrhea and initial constipation were somewhat more common than in typhoid cases. No relapses were reported, and the duration of the febrile stage was approximately the same as for typhoid. The only certain method of differentiation was identification of the causative organism.

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CHAPTER II

INFLAMMATORY DISEASES OF THE RESPIRATORY TRACT (BRONCHITIS, INFLUENZA, BRONCHOPNEUMONIA, LOBAR PNEUMONIA) [a]

In approaching the consideration of the serious and fatal inflammations of the respiratory tract which formed by far the most important factor in the sickness and death records of the Army during the World War, it is first necessary to take a general view of the subject in the attempt to determine, if possible, the causes that led to the large morbidity and mortality from respiratory diseases in general, rather than to limit ourselves to the consideration of each form of disease separately.

The mortality from respiratory diseases during the World War was due almost entirely to pneumonia, primary or secondary.[1] In any set of communities the size of the mobilization camps of the Army during the war, pneumonia is to be expected to some extent. The usual type of pneumonia occurring among young male adults in civil life is of course primary lobar pneumonia, running a fairly definite course and, usually, recognized easily both clinically and post mortem. That such cases occurred among the troops is beyond question. The proportion of such cases, however, is impossible to determine. McCallum expressed the opinion, after studying the pneumonias at Camp Travis, Tex., in the late winter of 1917–18, that they were relatively few in number and distinguished mainly by their mildness as compared to those seen in civil communities.[2] However, it was early recognized clinically that in the larger number of cases observed in the camps the pneumonia was of an atypical nature. The onset tended to be slower than that of the lobar pneumonia of civil life; the course more prolonged. Crisis was relatively rare; physical signs were slow of development and of patchy distribution and scattered in several lobes. These facts led careful observers to consider a large proportion of the cases as bronchopneumonia rather than as the usual lobar type. The results of post-mortem study of fatal cases lent confirmation to this distinction: The typical croupous consolidation of lobar pneumonia was relatively rare, patchy consolidation of a suppurative character more frequent. Even when the consolidation involved nearly or quite an entire lobe, careful study often showed evidence of the formation of such lobar consolidation by the confluence of smaller areas, lobular in origin.

Inasmuch as bronchopneumonia is almost invariably a complicating or secondary, rather than a primary infection, and its incidence in men of military age, generally speaking, is very low as compared to that of the lobar type, attention was at once focused on the coincident epidemic of measles as the probable primary cause of the pneumonias. That this disease was indeed a large factor in the causation of the pneumonias of the early days of the mobilization camps of the World War is shown in the consideration of that disease.

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[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

However, in many, if not in most camps, the peak of the pneumonia incidence did not coincide with that of the measles and in the light of subsequent events attention is directed to the possible occurrence in the camps at this time of another disease also complicated by fatal pneumonia, namely, influenza.

It will be shown that influenza, at least in its so-called endemic form, was a considerable factor in the sick rates of the Army for some years before the World War. It has always been held responsible for a small but varying mortality in the civil population according to the reports of the Census Bureau. It is the consensus of opinion of those who have investigated the subject that minor but distinct epidemic waves of this disease have occurred every few years, in each instance accompanied by an increase in the pneumonia mortality. Cases of influenza were reported from the camps from the earliest days of the mobilization; doubtless many more cases were not recognized owing to the mildness of the type prevailing during the fall of 1917. It is impossible, therefore, to estimate the number of influenza cases that occurred among the troops during these early months. But that the disease was present will be shown in a manner that will leave very little room for doubt, and its fluctuations from month to month, as shown by its effect on the number of admissions for the total respiratory diseases and by its effect on the amount and character of the prevalent pneumonia, can be shown with some definiteness.

Unfortunately for the exactness of our records in this class of diseases the clinical characteristics of mild influenza are such as to lead to its ready confusion with several of the milder so-called common respiratory diseases. Of these, bronchitis, tonsillitis, and pharyngitis are the leading diseases with which many of the earlier cases of influenza were confused. When the outbreak was at its height the uniformity of symptoms presented by large numbers of cases made confusion almost impossible and at the time of an epidemic wave in the majority of instances the cases were correctly diagnosed. However, in certain camps there were pathological purists who refused to give sanction to the diagnosis of influenza unless it was possible to demonstrate the presence of the bacillus of Pfeiffer. This attitude was evidently extreme, in view of the doubt cast in recent years on the specificity of the rôle of this organism in influenza; but the fact remains that in all of the epidemic waves to be described, even in the generally recognized fall outbreak of 1918, there was not only an increase in the number of cases diagnosed as influenza but also a corresponding increase in the "other respiratory diseases." One camp reported a preponderant number of influenza cases, another simultaneously suffering from the same epidemic wave reported few influenza cases, but a great increase in the common respiratory diseases. Even in the 1918 fall wave, three camps—Fremont, Calif.; Gordon, Ga.; and Wheeler, Ga.[3]—apparently insisted on a bacteriological diagnosis, which was not forthcoming, and reported their epidemic cases as "other respiratory diseases." These two factors then, the impossibility of making an exact clinical diagnosis of influenza in the absence of the great outbreak, and the insistence by some on the bacteriological diagnosis even in the presence of undoubted waves of the disease, make it impracticable to base conclusions as to the varying incidence of influenza in the Army camps on the reported cases of that disease alone. In studying the varying incidence of influenza, therefore,

it becomes necessary to use not only the figures for that disease as reported, but also those for certain other acute respiratory infections. In using this combined figure we are undoubtedly including a certain number of noninfluenzal cases. In view of the number of cases involved, however, and of the more or less constant incidence of these diseases as usually observed, it is believed that the use of this figure will give the most reliable comparative index of the month-to-month incidence of influenza that it is possible to obtain.

The study of the relations between the incidence of the common respiratory diseases and of the pneumonias, therefore, should serve to throw light both on the causation of the high pneumonia incidence and mortality as well as on the character of the responsible primary infection. For this reason, it seems impossible to consider separately the epidemiology of the pneumonias and of influenza.

It should be understood in studying the various charts presented that the system of recording admissions for disease in use in the Army during the World War referred each case back to date of admission. Thus, if a man was admitted with measles during one month and his complicating pneumonia did not develop until the following month, the pneumonia would be reported as occurring in the former month, the date of the original admission. This simplifies the reading of the graphs as, for instance, the peak of measles admission and of the complicating pneumonias will thus appear in the same month. No allowance is necessary for the lapse of time between the development of the primary disease and the onset of the complication.

As to the accuracy and completeness of the figures used in the following pages, it must be said that doubtless many cases of pneumonia escaped record in the monthly tables used, by reason of the fact that the disease of record was taken to be the one given as the cause of the original admission. Complications and intercurrent diseases were included in the tables of concurrent diseases, solely for enlisted men in the United States and Europe, and when complicating disease, not injury, but were not classified by months, except to some extent those occurring in influenza, and in measles. However, for the present study the figures are very satisfactory and while doubtless many pneumonia cases were recorded under some other heading this error was undoubtedly a nearly constant one and the important facts, the fluctuations in the rates from month to month, are believed to be shown with substantial accuracy.

EPIDEMIOLOGY

The history of epidemic influenza dates back to the dark ages of medicine and much of it is involved in the obscurity of uncertain diagnosis. It is outside the sphere of this chapter to consider this even in the most cursory manner. Suffice it to say that the records of periodic visitations of epidemic acute respiratory disease of such character as to be reasonably supposed to have been influenza go back almost as far as does written history. These outbreaks have been of varying character and the descriptions sometimes lead to doubt as to the influenzal character of the disease. Some outbreaks were associated with large numbers of fatal cases of pneumonia while others equally widespread were accompanied by relatively slight fatality. Before the pandemic of 1918 the

latest general outbreak of the disease was that of 1889–90,[4] involving very large numbers of cases but, compared to the more recent outbreak, a small loss of life. Even in this outbreak the fatality of the various waves varied greatly. Since that pandemic several minor outbreaks of less general distribution have occurred, notably in the winter of 1907–08 [4] and in that of 1915–16.[5] Neither of these led to enough excess mortality to make any considerable impression on the mortality curves although it is evident on careful study.

The mortality figures for the United States registration area, 1911–1920,[6] show a regularly varying curve for deaths from influenza and from the pneumonias, highest during the winter months, although at times the highest point was reached in March. (Chart V.) The highest monthly rates for influenza prior to 1918 were reached in the winter of 1915–16, and were accompanied by some increase in the pneumonia death rates. This increased death rate for pneumonia continued with slight remission during the succeding years up to the great pandemic of 1918, after which the death rates for influenza for the

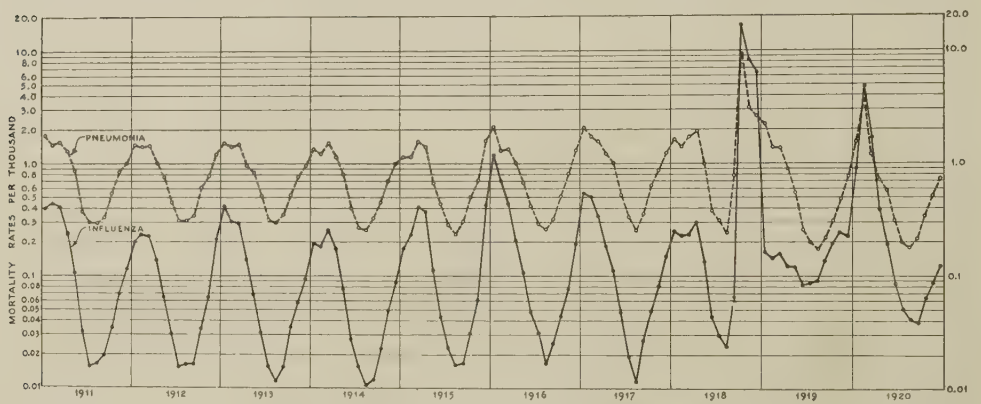

CHART V.—Comparative trends of mortality rates per 1,000 for pneumonia and influenza, United States registration area for deaths, 1911–1920

whole area dropped back to normal. It was noted, however, that certain cities, New Orleans for example, showed an even higher death rate for influenza in the winter of 1917–18 than had been the case two years earlier. There appears to have been then a certain possible increase in the prevalence of influenza and to a greater extent of pneumonia in the few years preceding the great outbreak of 1918.

For the Army, statistics are available since 1840, except for the period of the Mexican War. There is little evidence in the records of any exceptional prevalence of influenza during the Civil War.

From the end of the Civil War to the beginning of the World War there was an almost uninterrupted slow decline in the admission rates for pneumonia in the Army.[7] This was broken only by two considerable elevations, one in 1888, the year before the outbreak of the 1889–90 influenza pandemic, and a second, almost as high, coinciding with the mobilization for the Spanish-American War in 1898, from 1913 there has been a very slight tendency for the rates to rise. The figures for influenza are less satisfactory owing to the confusion as

to the exact diagnosis of the condition. Following the Civil War relatively low rates prevailed for a few years to be succeeded by a period of some 15 years when the reported rate ran nearly as high as that reached during 1890, when the peak of the pandemic reached the Army. Immediately preceding the pandemic, however, several years were recorded with as low a rate as was the case later. Following the 1889–90 pandemic the rates gradually descended; low points were reached in 1902 and in 1914. The case fatality of the pneumonias was high during the Civil War and again reached almost the same point in 1918. The high point in the intervening years was reached in 1887, after which time there was a tendency to a gradual decline. In 1904, 1907, and 1915, all years in which influenza was noted as more than usually prevalent in the civil population, there is a simultaneous rise. In the years previous to the 1889–90 pandemic there appears to be no easily traceable relation between them. With the exceptions of these relations, shown both in the civil and military statistics between the incidence and the mortility for influenza and pneumonia, it would appear that the really significant fact brought out by these figures is that there is present at all times even in the interepidemic periods a disease of such a character clinically as to lead large numbers of physicians, both in the Army and in civil practice, to call it influenza. Whether this disease is the same as that occurring in epidemic outbreaks remains for the future to decide, and the decision will be made when etiologic studies have progressed to the point that will render it possible to make a diagnosis based on the identity of the inciting agent.

PREVALENCE AND IMPORTANCE DURING THE WAR PERIOD

General tables for the period of the war have been prepared showing the total number of admissions and deaths from influenza, bronchitis, bronchopneumonia, and lobar pneumonia in the various racial groups comprising the Army, and for the different countries in which our troops were stationed. Rates have also been calculated for each of these groups based on a strength which was obtained by the addition of the mean annual strengths for each of the years of the war. The resulting rate is an average of the annual rates weighted for the variations of strength from year to year. The figures thus obtained possess decided comparative value; they show the results that may be expected from different races and in the different climates over a considerable period of time in the presence of epidemic outbreaks of influenza. On the other hand, they are open to the objection that applies to all single figures purporting to represent averages—the details are inevitably obscured. For the detailed study of the epidemiology of these conditions the rates by months for the different groups are vastly preferable. These monthly rate are given in the study of the effect of race and of length of service on the incidence and the mortality of the diseases under consideration. The consideration of these general tables, however, will serve to give an outline of the respiratory disease situation in the Army during the World War, and certain general conclusions may be drawn from them as to the relative prevalence and fatality of these diseases in the different groups.

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TABLE 10.—*Respiratory diseases. Primary admissions, officers and enlisted men, United States Army, by countries, April 1, 1917, to December 31, 1919. Absolute numbers and annual ratios per 1,000 strength*

	Influenza		Bronchitis		Bronchopneumonia		Lobar pneumonia		Total	
	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000
Total officers and enlisted men (including native troops)	791,907	191.82	255,148	61.80	32,572	7.89	45,774	11.09	1,125,401	272.60
Total officers and enlisted men, American troops	783,895	191.56	253,323	61.89	32,386	7.91	45,525	11.12	1,115,129	272.48
Total officers	28,621	138.68	11,876	57.54	1,021	4.95	975	4.72	42,493	205.89
Enlisted men, American:										
White	671,322	186.50	214,561	59.61	24,422	6.78	31,903	8.86	942,208	261.75
Colored	59,448	207.46	20,045	69.95	4,825	16.84	11,482	40.07	95,800	334.32
Color not stated	24,504	.....	6,841	.....	2,118	.....	1,165	.....	34,628	.....
Total	755,274	194.35	241,447	62.13	31,365	8.07	44,550	11.46	1,072,636	276.01
U. S. Army in the United States (including Alaska):										
Officers	17,970	144.61	8,062	64.88	444	3.57	527	4.24	27,003	217.30
Enlisted men—										
White	476,816	242.62	148,401	75.51	13,297	6.77	21,886	11.14	660,400	336.04
Colored	38,863	266.51	12,963	88.88	2,759	18.92	7,016	48.10	61,601	422.41
Total	515,679	244.27	161,364	76.43	16,056	7.61	28,902	13.69	722,001	342.00
Total officers and enlisted men	533,649	238.70	169,426	75.79	16,500	7.38	29,429	13.16	749,004	335.03
U. S. Army in Europe (excluding Russia):										
Officers	9,743	132.15	3,517	47.70	552	7.49	424	5.75	14,236	193.09
Enlisted men—										
White	176,240	119.92	60,098	40.89	10,761	7.32	9,000	6.12	256,099	174.25
Colored	18,619	152.10	6,681	54.58	1,986	16.32	4,149	33.89	31,435	256.89
Color not stated	23,859	.....	6,679	.....	2,100	.....	1,076	.....	33,714	.....
Total	218,718	137.38	73,458	46.14	14,847	9.33	14,225	8.93	321,248	201.78
Total officers and enlisted men	228,461	137.15	76,975	46.21	15,399	9.24	14,649	8.79	355,484	201.39
Officers, other countries	908	108.25	297	35.41	25	2.98	24	2.86	1,254	149.50
Philippine Islands (including China):										
White enlisted men	1,055	62.08	713	41.95	14	.82	49	2.88	1,831	107.73
Colored enlisted men	465	104.35	70	15.71	6	1.35	5	1.12	546	122.53
Total	1,520	70.86	783	36.50	20	.93	54	2.52	2,377	110.81
Hawaii:										
White enlisted men	1,012	62.62	874	54.08	11	.68	58	3.59	1,955	120.97
Colored enlisted men	183	55.14	146	43.96	6	1.81	11	3.31	346	104.22
Total	1,195	61.35	1,020	52.41	17	.87	69	3.54	2,301	118.17
Panama: White enlisted men	3,272	166.18	866	43.99	7	.36	8	.41	4,153	210.94
Other countries:										
White enlisted men	5,250	.....	1,857	.....	99	.....	235	.....	7,441	.....
Colored enlisted men	127	.....	30	.....	12	.....	34	.....	203	.....
Enlisted men, color not stated	587	.....	153	.....	11	.....	17	.....	768	.....
Total	5,964	.....	2,040	.....	122	.....	286	.....	8,412	.....
Transports:										
White enlisted men	7,677	78.75	1,752	17.97	233	2.39	667	6.84	10,329	105.95
Colored enlisted men	1,191	113.05	155	14.71	56	5.32	267	25.34	1,669	158.42
Enlisted men, color not stated	58	.....	9	.....	7	.....	72	.....	146	.....
Total	8,926	82.62	1,916	17.74	296	2.74	1,006	9.31	12,144	112.41
Native enlisted men:										
Philippine Scouts	2,517	135.51	761	40.97	152	8.18	122	6.57	3,552	191.23
Hawaiians	1,052	187.35	230	40.96	5	.89	49	8.73	1,336	237.93
Porto Ricans	4,443	375.51	834	70.49	29	2.45	78	6.59	5,384	455.04
Total	8,012	222.40	1,825	50.66	186	5.16	249	6.19	10,272	284.41

Table 10 shows the absolute number of primary admissions for racial groups and for totals. Thus it is seen that influenza, bronchitis, bronchopneumonia, and lobar pneumonia were responsible for 1,125,401 primary admissions in the entire Army. Of these, influenza is credited with 791,907 admissions; bronchitis, 255,148; bronchopneumonia, 32,572; lobar pneumonia, 45,774. These diseases occurred also concurrently with, or secondarily to, other diseases or surgical conditions for which patients primarily were admitted to hospital, and were, in many instances, probably responsible for much of the mortality which occurred and was otherwise reported. It is not now possible to discover the total number of instances in which influenza, bronchitis, bronchopneumonia, and lobar pneumonia occurred concurrently with other diseases or as complications of surgical conditions; however, partial results are possible. Thus, it is possible to account for 798,509 cases of influenza, 279,597 of bronchitis, 96,495 of bronchopneumonia, and 76,147 of lobar pneumonia. Allowing for the instances where diseases of this group complicated other diseases of the same group, it is possible to account for 797,993 cases of influenza, 272,735 of bronchitis, 37,334 of bronchopneumonia, and 51,115 of lobar pneumonia, a total of 1,159,177 cases of respiratory diseases; which, as stated above, can be only an approximation.

There were in all, during the World War, 3,515,464 admissions to sick report for disease. Of these, 32 per cent were primarily for respiratory disease, while an additional 0.96 per cent of the total suffered from these diseases secondarily. The comparison of the annual ratios per thousand also is shown in Table 10. The total mean annual strength of the Army for the years 1917–1919 was 4,128,479.[8] It can be said, then, that 18.33 per cent, or 1 man to every 5.17, contracted influenza in the service, 6.27 per cent, or 1 to every 15.14, contracted bronchitis, 0.86 per cent, or 1 to 110.58, contracted bronchopneumonia, and 0.17 per cent, or 1 to 80.77, contracted lobar pneumonia. The 1,159,177 cases of respiratory diseases represent 26.63 per cent of the total number of men in the Army, or 1 to every 3.5 men. Venereal disease was responsible for the next largest number of admissions (357,969), followed by mumps with 230,356 primary admissions and acute tonsillitis with 176,408.

As to group incidence, the figures show that the incidence was in general higher among the American enlisted men (276.01) than among officers (205.89). The highest admission rates shown by any group was for the enlisted men from Porto Rico. Of their total rate of 455.04 per 1,000 for respiratory diseases, however, 375.51 was for influenza. Their primary admissions for the pneumonias, especially for bronchopneumonia (2.45), were relatively low. The next highest admission rate was shown by the colored enlisted men in the United States (422.41). The colored rates were consistently higher than those for the whites under the same conditions except for the colored enlisted men in Hawaii, who had the lowest rate for total respiratory disease (104.22) shown by group. The rate for the enlisted men of the Philippine Scouts (191.23) was lower than that of the Army as a whole (272.60), while that for the enlisted Hawaiians (237.93) was also below the average. The rate for the Philippine Scouts (191.23) was higher than that for the white enlisted men in the Philippine Islands (107.73) and also higher than that for colored troops (122.53) in the same territory.

In general, troops serving in the Tropics showed lower admission rates than those in temperate climates. However, the rate for white enlisted men in Panama (210.94) was higher than the corresponding rate in Europe (174.25). The explanation of this is not forthcoming unless it be based on the fact that the troops in Europe had passed through the preliminary waves of the epidemic in the United States and had acquired an immunity which was not possessed by the troops in Panama where the earlier waves of the influenza invasion made little impression. This fact possibly accounts for the relative immunity of the troops in Europe as compared to the corresponding groups in the United States. It is not believed that the rates as given for men on transports are comparable fairly with the others, since the difficulty of obtaining a satisfactory strength basis of computation or admission rate is insuperable. The strengths used appear to have been too high and the corresponding rates low. It is generally admitted that during the fall wave of influenza (1918) the incidence and mortality on the transports was high, undoubtedly due to the necessarily limited space available per man.

Among the military personnel during the World War there were 44,270 deaths, occurring in cases having a primary diagnosis of influenza, bronchitis, bronchopneumonia, or lobar pneumonia.[1] Of these, 24,664 are charged to influenza, 439 to bronchitis, 9,022 to bronchopneumonia, and 10,145 to lobar pneumonia. There were, however, large numbers of cases of these diseases reported, secondary to other diseases as previously stated. If to these associated cases we apply the same case fatality rates as shown by the primary admissions and deaths, we find that there were, in addition to the deaths given above, 189 from influenza, 30 from bronchitis, 1,319 from bronchopneumonia, and 1,184 from lobar pneumonia. This method gives an estimated total of 24,853 deaths from influenza as recorded, 469 from bronchitis, 10,341 from bronchopneumonia, and 11,329 from lobar pneumonia, a grand total of 46,992. This is nearly as large a total as that of the battle deaths, American Expeditionary Forces—50,385.[1] The disease responsible for the next largest number of deaths was tuberculosis, as a primary admission, with 2,766, followed by measles with 2,370 (also mainly due to pneumonia) and epidemic meningitis, with 1,836.

Of all the deaths charged to influenza, 99.4 per cent were recorded as due secondarily to pneumonia, of which 66.1 per cent of the total were described as bronchopneumonia and 33.3 per cent as lobar pneumonia. It appears that less than 1 per cent of the influenza deaths showed no recognized signs of pneumonia; that a very few cases are fatally overwhelmed by the primary infection appears probable. Of the deaths charged to bronchitis 84.5 per cent were recorded as secondarily due to pneumonia, of which 52 per cent were described as bronchopneumonia and 32.5 per cent as lobar pneumonia, a proportion of 1.6 to 1 as compared with almost exactly 2 to 1 in the cases recorded as secondary to influenza. It is evident that, in so far as the bronchitis cases were of an influenzal nature, the cases were evidently of a much milder average than those diagnosed frankly as influenza; the greater number of them, too, occurred in the earlier months of the war period. That this was largely true will be shown later. The men, then, who suffered from this infection in a form

severe enough to induce pneumonia and death were presumably the more susceptible individuals. The proportion of lobar pneumonia to broncho-pneumonia is seen to be higher in this group than in those frankly diagnosed as influenza. This agrees with the relations of these types of pneumonia as noted for the white and colored races, in which the more susceptible race showed a much larger relative proportion of lobar pneumonia both in admissions and in deaths.

The total deaths from disease during the war were 58,119, of which those from respiratory diseases (as computed above) were 46,992, or 80.85 per cent. Nearly all of these deaths from respiratory diseases, as has been shown, were the result of pneumonia.

TABLE. 11.—*Respiratory diseases. Deaths, officers and enlisted men, United States Army, by countries, April 1, 1917–December 31, 1919. Absolute numbers and ratios per 1,000*

	Influenza		Bronchitis		Broncho pneumonia		Lobar pneumonia		Total	
	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000
Total officers and enlisted men (including native troops)	24,664	5.97	439	0.11	9,022	2.19	10,145	2.46	44,270	10.73
Total officers and enlisted men, American troops	24,575	6.00	439	.11	8,992	2.20	10,099	2.47	44,105	10.78
Total officers	596	2.89	22	.11	192	.93	194	.94	1,004	4.87
Enlisted men, American:										
White	20,888	5.80	334	.09	6,480	1.80	7,073	1.96	34,775	9.75
Colored	2,287	7.98	42	.15	1,063	3.71	2,222	7.75	5,614	19.59
Color not stated	804	-------	41	-------	1,257	------	610	-------	2,712	-------
Total	23,979	6.17	417	.11	8,800	2.26	9,905	2.55	43,101	11.09
U. S. Army in the United States (including Alaska):										
Officers	387	3.11	12	.10	80	.64	94	.76	573	4.61
Enlisted men—										
White	14,617	7.44	24	.01	3,429	1.74	4,330	2.20	22,400	11.39
Colored	1,567	10.74	3	.02	634	4.35	1,363	9.35	3,567	24.46
Total	16,184	7.67	27	.01	4,063	1.92	5,693	2.70	25,967	12.30
Total officers and enlisted men	16,571	7.41	39	.02	4,143	1.85	5,787	2.59	26,540	11.87
U. S. Army in Europe (excluding Russia):										
Officers	191	2.59	10	.14	106	1.44	93	1.26	400	5.43
Enlisted men—										
White	5,753	3.91	304	.21	2,919	1.99	2,414	1.64	11,390	7.75
Colored	628	5.15	38	.31	395	3.23	778	6.36	1,839	15.05
Color not stated	794	-------	40	-------	1,244	-------	534	-------	2,612	-------
Total	7,175	4.51	382	.24	4,558	2.86	3,726	2.34	15,841	9.95
Total officers and enlisted men	7,366	4.42	392	.24	4,664	2.80	3,819	2.29	16,241	9.75
Officers, other countries	18	2.15	-------	-------	6	.72	7	.83	31	3.70
Philippine Islands (including China):										
White enlisted men	2	.12	1	.06	4	.24	7	.41	14	.83
Colored enlisted men	-------	-------	-------	-------	4	.90	1	.22	5	1.12
Total	2	.09	1	.05	8	.37	8	.37	19	.88
Hawaii:										
White enlisted men	3	.06	-------	-------	-------	-------	3	.19	6	.25
Colored enlisted men	2	-------	-------	-------	2	.60	1	.30	5	.90
Total	5	.06	-------	-------	2	.10	4	.21	11	.37
Panama: White enlisted men	9	.45	-------	-------	-------	-------	2	.10	11	.56

TABLE 11.—*Respiratory diseases. Deaths, officers and enlisted men, United States Army, by countries, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*—Continued

	Influenza		Bronchitis		Bronchopneumonia		Lobar pneumonia		Total	
	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000
Other countries:										
White enlisted men	137		3		48		54		242	
Colored enlisted men					13		8		28	
Enlisted men, color not stated	2				9		5		19	
Total	146		3		70		67		286	
Transports:										
White enlisted men	367	3.76	2	.02	80	.83	263	2.70	712	7.31
Colored enlisted men	83	7.88	1	.09	15	1.42	71	6.74	170	16.13
Enlisted men, color not stated	8		1		4		71		84	
Total	458	4.24	4	.04	99	.92	405	3.75	966	8.95
Native enlisted men:										
Philippine Scouts	17	.92			27	1.45	25	1.35	69	3.72
Hawaiians	8	1.42					5	.89	13	2.31
Porto Ricans	64	5.41			3	.89	16	1.35	83	7.65
Total	89				30		46		165	

TABLE 12.—*Respiratory diseases. Officers and enlisted men, United States Army, by countries, April 1, 1917, to December 31, 1919. Case fatalities and ratios of bronchopneumonia to lobar pneumonia*

	Case fatality					Ratio, bronchopneumonia to lobar pneumonia	
	Influenza	Bronchitis	Bronchopneumonia	Lobar pneumonia	Total	Admissions	Deaths
Total officers and enlisted men (including native troops)	3.1	0.17	27.7	22.2	3.9	0.71	0.89
Total officers and enlisted men, American troops	3.1	.17	27.7	22.2	4.0	.71	.89
Total officers	2.2	.18	18.8	19.9	2.4	1.05	.99
Enlisted men, American:							
White	3.1	.16	26.5	22.2	3.7	.76	.91
Colored	3.8	.21	22.0	19.3	5.9	.42	.48
Color not stated	3.3	.60	59.3	52.3	7.8	1.82	2.06
Total	3.2	.17	28.1	22.2	4.0	.70	.89
U. S. Army in the United States including Alaska):							
Officers	2.2	.15	18.0	17.8	2.0	.84	.85
Enlisted men—							
White	3.1	.16	35.8	19.8	3.4	.61	.79
Colored	4.0	.02	23.0	19.4	5.8	.39	.46
U. S. Army in Europe (excluding Russia):							
Officers	2.0	.28	19.2	21.9	2.8	1.30	1.14
Enlisted men—							
White	3.3	.51	27.1	26.8	4.4	1.19	1.21
Colored	3.4	.57	19.9	18.8	5.8	.49	.51
Officers in other countries	2.0		24.0	29.1	2.5	1.04	1.17
Philippine Islands:							
White enlisted men	.19	.14	28.6	14.3	.8	.29	.57
Colored enlisted men			66.6	20.0	.92	1.20	4.00
Hawaii:							
White enlisted men	.30			5.2	.3	.19	
Colored enlisted men	1.1		33.3	9.1	.9	.55	2.0
Panama: White enlisted men	.27			25.0	.27	.87	

Of the race groups, the colored troops show consistently higher rates of death than the whites. The death rates for Porto Rican troops (7.65) is much lower than that of the total colored (19.59) and lower also than the total white rate (9.75). It about equals the rate observed for the white troops in Europe (7.75). In view of their high admission rate, their low fatality emphasizes

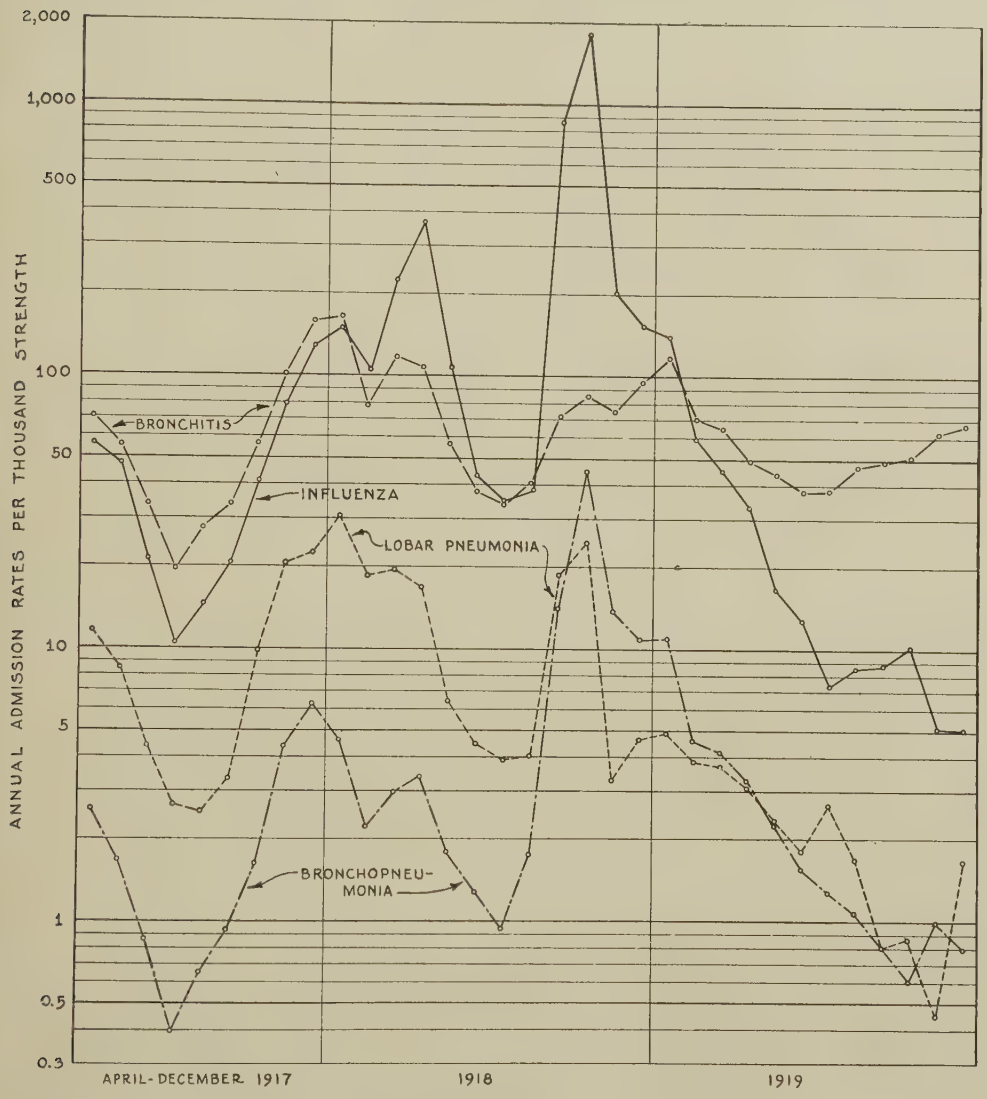

CHART VI.—Annual admission rates per 1,000 strength, white enlisted men in the United States, for influenza, bronchitis, bronchopneumonia, and lobar pneumonia, by months, April, 1917, to December, 1919

the influence of the climate in which a large proportion of these men were stationed. This applies also to the low rates for the Philippine Scouts (3.72) and the Hawaiians (2.31). The death rates for officers (4.87) were lower than for enlisted men (11.09). This difference is more marked in the United States than in Europe. The influence of environment is markedly shown in

the lower death rates for the tropical countries even in groups that show relatively high admission rates as in the case of white troops in Panama (0.56) and in that of the Porto Rican troops (7.65).

In attempting to trace the various waves of the influenza epidemic, use has been made of the admission and death rates of influenza, bronchitis, bronchopneumonia, and lobar pneumonia, combined in each case into a single rate. From the number of admissions and the number of deaths, the case fatality has been calculated. Tables 13 to 22, inclusive, and Charts VIII to XIII

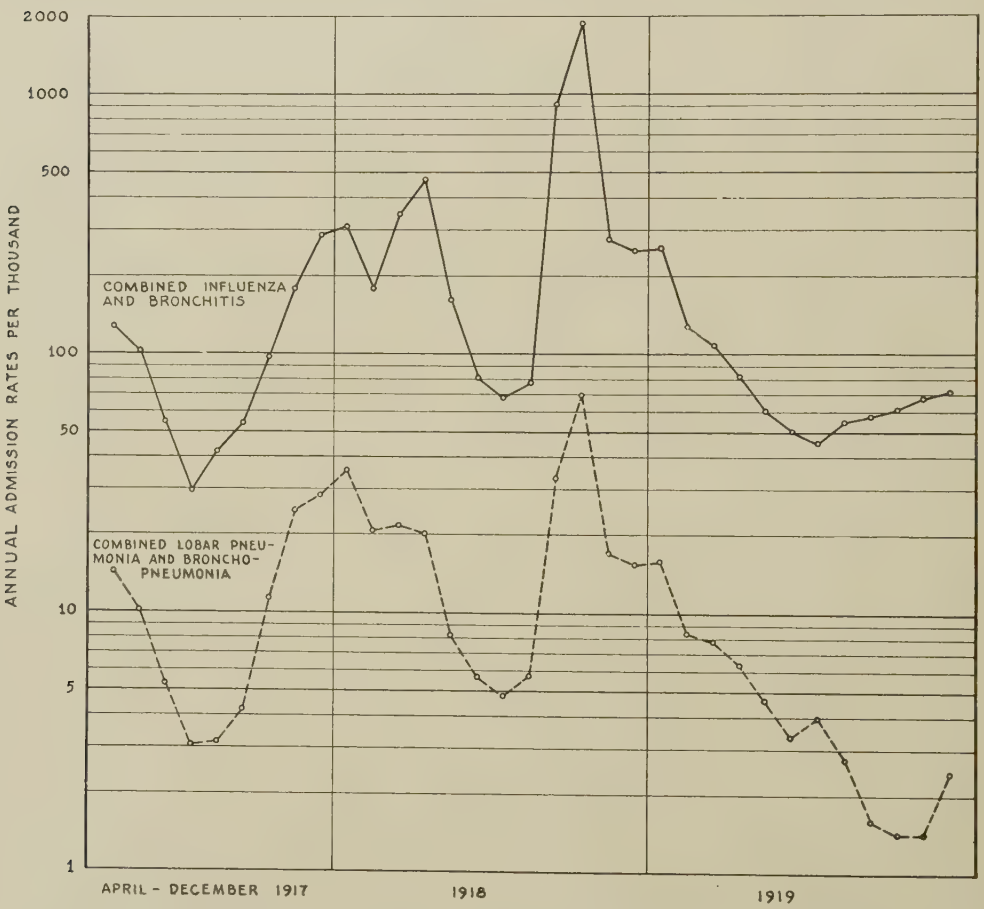

CHART VII.—The relations between the annual admission rates per 1,000 strength, white enlisted men in the United States, of the combined influenza and bronchitis and the combined lobar pneumonia and bronchopneumonia, by months, April, 1917, to December, 1919

show these factors for various specific groups of the Army. The epidemic prevalence of influenza in a certain month shows itself on the charts referred to in one or more of three ways, increases being in the admission rate, in the death rate, or in the case fatality. Differences in race or in length of service are accompanied by differences in the way in which a group reacts to the presence of influenza. When the epidemic is at its worst all three factors are

markedly affected, but in the case of milder waves only that factor to which the group responds most sensitively may show indications of the presence of the epidemic wave. Thus, in general, the colored race shows less variation

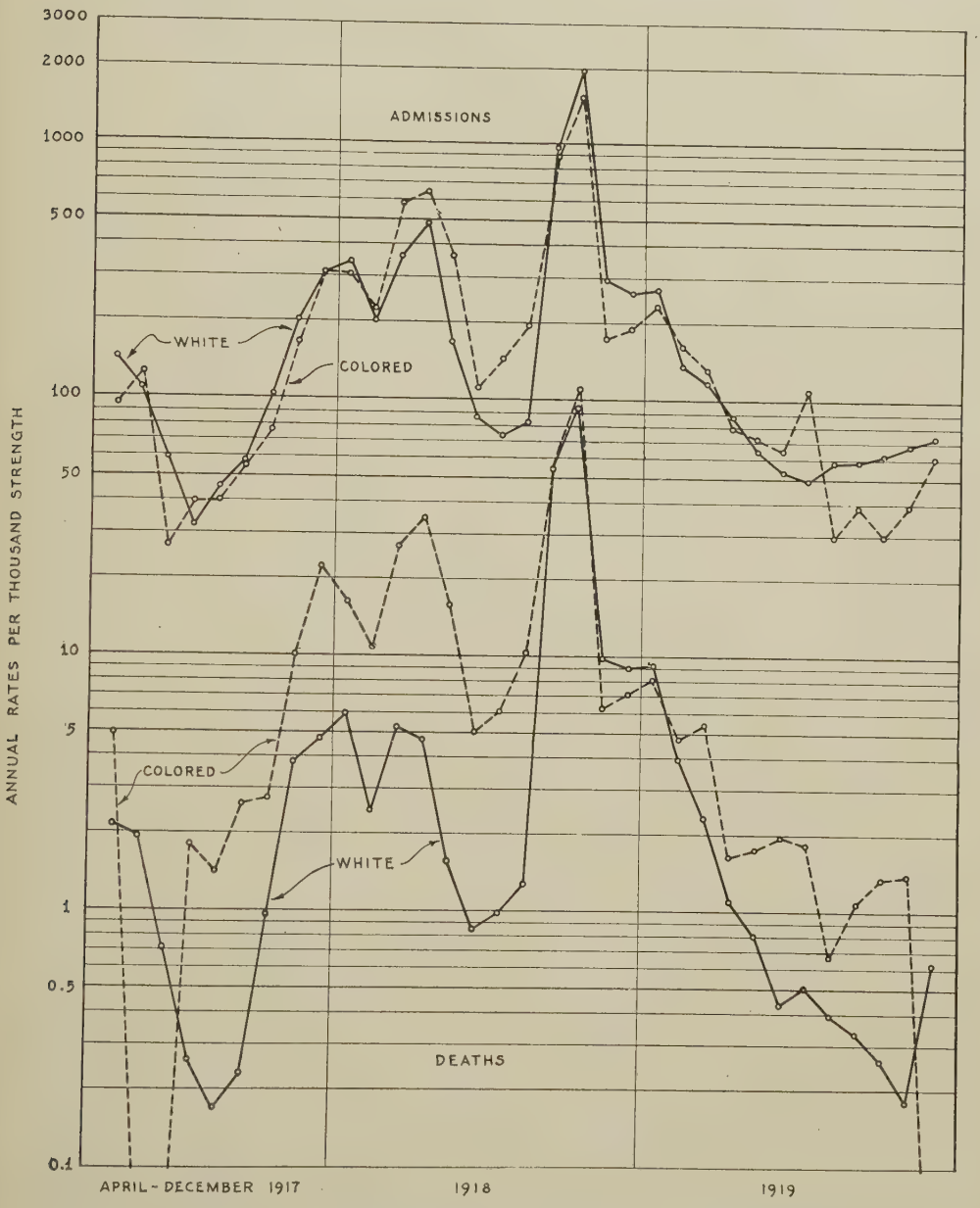

CHART VIII.—Annual admission and death rates per 1,000 strength for white and colored enlisted men in the United States, total respiratory group of diseases, by months, April, 1917, to December, 1919

in case fatality and more in morbidity than does the white race. So, too, the process of "seasoning" alters the relation of the case fatality and the admission rates to the death rates. With these preliminary facts in mind it is possible

to examine the charts of annual rates by months and to determine with some degree of probability those months in which an epidemic wave had its occur-

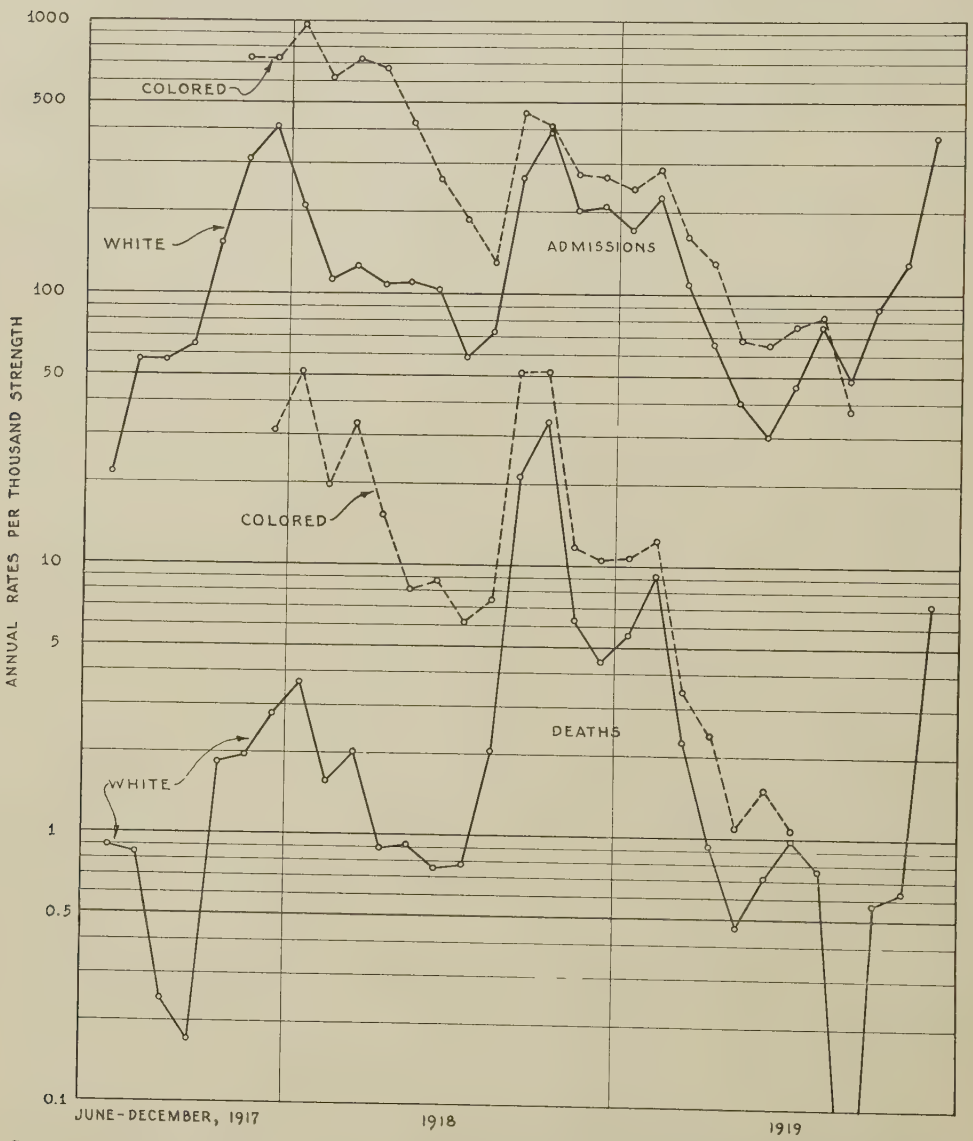

CHART IX.—Annual admission and death rates per 1,000 strength for white and colored enlisted men in Europe, total respiratory group of diseases, by months, June, 1917, to December, 1919. (No rates shown when strength was less than 1,000)

rence. While statistics classified by weeks would be much more desirable for this purpose, such are not available, and the figures by months give a very clear-cut picture.

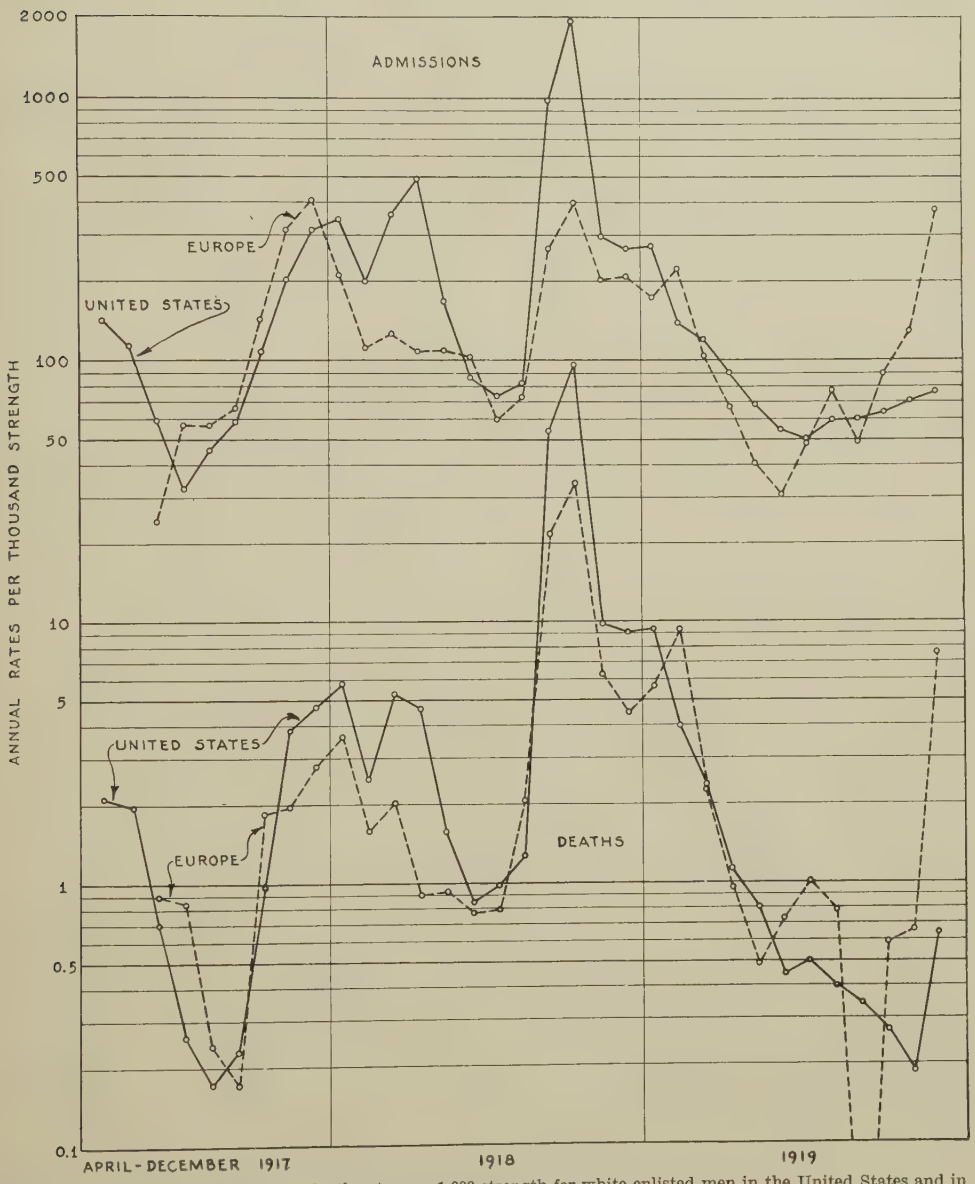

CHART X.—Annual admission and death rates per 1,000 strength for white enlisted men in the United States and in Europe, total respiratory group of diseases, by months, April, 1917, to December, 1919

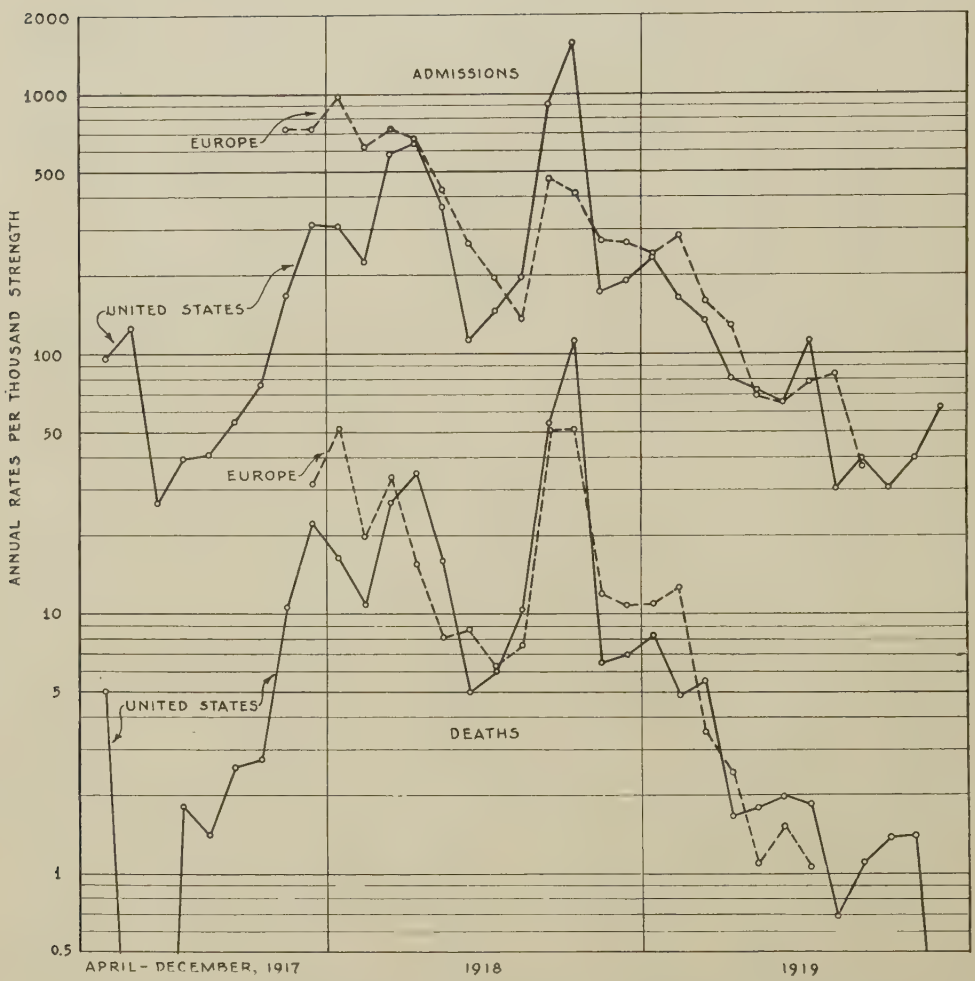

CHART XI.—Annual admission and death rates per 1,000 strength for colored enlisted men in the United States and in Europe, total respiratory group of diseases, by months, April, 1917, to December, 1919. (No rates shown when strength was less than 1,000)

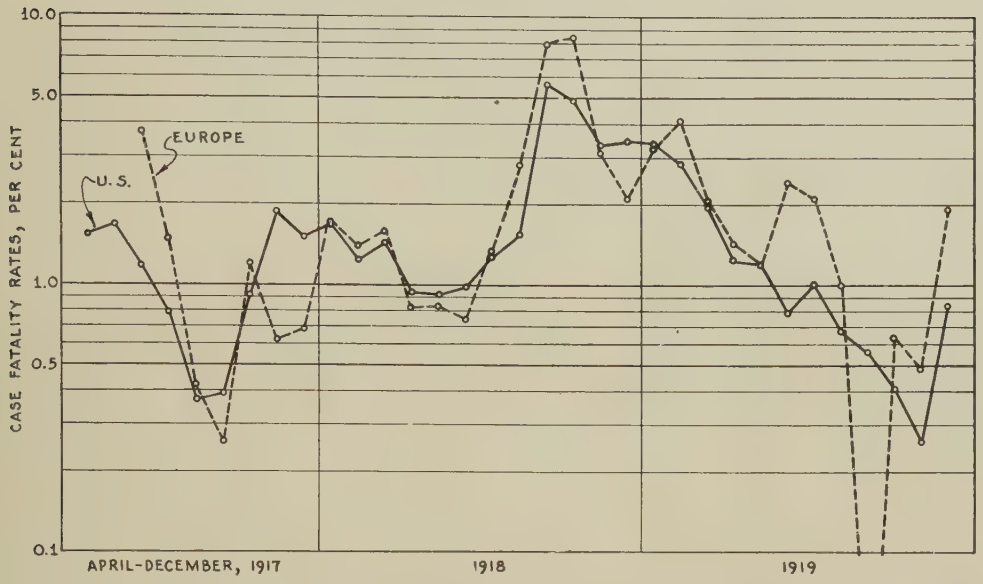

CHART XII.—Case fatality rates (per cent), total respiratory group of diseases for white enlisted men in the United States and in Europe by months, April, 1917, to December, 1919

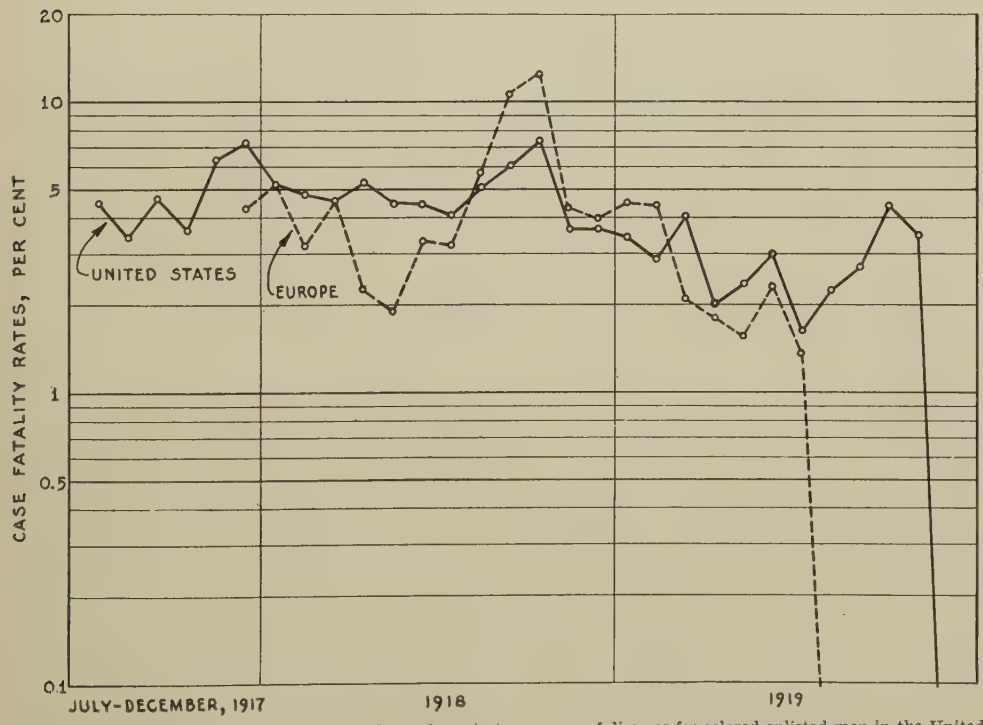

CHART XIII.—Case fatality rates (per cent), total respiratory group of diseases for colored enlisted men in the United States and in Europe, by months, July, 1917, to December, 1919

TABLE 13.—*Total respiratory diseases (influenza, bronchitis, bronchopneumonia, and lobar pneumonia), white and colored enlisted men, United States Army, in the United States, by months, from April 1, 1917, to December 31, 1919*

	Annual admission rates per 1,000 strength		Annual death rates per 1,000 strength		Case fatality rates (per cent)	
	White	Colored	White	Colored	White	Colored
1917						
April	141.97	96.07	2.16	4.92	1.52	5.12
May	113.07	125.53	1.91		1.67	
June	59.53	27.84	.70		1.18	
July	32.74	39.57	.26	1.80	.79	4.55
August	45.60	40.85	.17	1.41	.37	3.45
September	58.23	54.85	.23	2.55	.39	4.65
October	107.58	75.99	.98	2.75	.91	3.62
November	203.84	167.64	3.81	10.40	1.87	6.20
December	312.94	312.28	4.68	22.14	1.50	7.09
1918						
January	344.58	308.41	5.83	16.10	1.69	5.22
February	200.08	226.54	2.48	10.81	1.24	4.77
March	363.91	582.10	5.22	26.71	1.43	4.59
April	493.20	649.87	4.63	34.16	.94	5.26
May	167.51	368.70	1.54	16.57	.92	4.49
June	85.94	112.62	.84	4.98	.98	4.42
July	73.13	145.67	.93	5.95	1.27	4.08
August	83.05	197.79	1.27	10.13	1.53	5.12
September	974.36	896.71	54.06	53.86	5.55	6.01
October	1,978.15	1,584.95	95.69	111.66	4.84	7.05
November	296.27	172.86	9.74	6.37	3.29	3.69
December	266.65	191.41	9.08	6.92	3.41	3.62
1919						
January	271.90	236.39	9.14	8.09	3.36	3.42
February	138.01	163.75	3.87	4.73	2.80	2.89
March	118.13	134.14	2.30	5.38	1.95	4.01
April	89.37	80.08	1.09	1.61	1.22	2.01
May	65.84	72.73	.79	1.74	1.20	2.39
June	54.24	65.28	.43	1.94	.79	2.97
July	49.99	112.46	.50	1.80	1.00	1.60
August	58.46	29.98	.39	.67	.67	2.23
September	59.46	39.20	.33	1.06	.55	2.70
October	63.40	30.38	.26	1.32	.41	4.35
November	69.42	39.55	.18	1.36	.26	3.44
December	74.78	61.75	.62		.83	

TABLE 14.—*Total respiratory diseases (influenza, bronchitis, bronchopneumonia, and lobar pneumonia), white and colored enlisted men, United States Army in Europe, by months, from June, 1917, to December 31, 1919*

	Annual admission rates per 1,000 strength		Annual death rates per 1,000 strength		Case fatality rates (per cent)	
	White	Colored	White	Colored	White	Colored
1917						
June	24.15		0.89		3.69	
July	57.04		.84		1.47	
August	57.07		.24		.42	
September	65.92		.17		.26	
October	153.04		1.82		1.19	
November	311.49	733.67	1.94		.62	
December	407.17	733.18	2.76	31.39	.68	4.28
1918						
January	209.50	969.57	3.60	51.17	1.72	5.28
February	111.70	621.11	1.56	19.87	1.40	3.20
March	125.52	725.57	2.00	33.27	1.59	4.59
April	108.81	662.88	.89	15.15	.82	2.29
May	109.90	421.67	.91	8.06	.83	1.91
June	102.70	265.64	.76	8.67	.74	3.26
July	58.94	189.27	.78	6.10	1.32	3.22
August	73.14	130.62	2.02	7.45	2.76	5.70
September	263.80	473.05	21.05	50.48	7.98	10.67
October	397.00	408.51	33.52	50.75	8.44	12.42
November	200.66	272.07	6.19	11.78	3.08	4.33
December	207.91	266.26	4.42	10.52	2.13	3.95
1919						
January	171.32	241.63	5.55	10.77	3.24	4.46
February	223.48	283.59	9.18	12.35	4.11	4.35
March	108.28	160.38	2.23	3.41	2.06	2.13
April	65.84	129.51	.93	2.39	1.41	1.85
May	39.68	68.92	.47	1.09	1.18	1.58
June	30.13	65.64	.71	1.50	2.36	2.29
July	46.32	76.77	.97	1.06	2.09	1.38
August	76.24	82.76	.75		.98	
September	48.69	37.39				
October	88.89		.57		.64	
November	128.73		.63		.49	
December	371.41		7.19		1.94	

NOTE.—No rates given when strength less than 1,000.

TABLE 15.—*Annual admission rates per 1,000 strength, white enlisted men, in the United States, by months, from April 1, 1917, to December 31, 1919*

	Strength	Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia
1917					
April	183,758	56.03	71.64	2.61	11.69
May	245,454	47.08	55.87	1.66	8.46
June	309,205	21.00	33.26	.85	4.42
July	458,817	10.41	19.25	.39	2.69
August	562,714	14.65	27.77	.66	2.52
September	776,466	20.25	33.72	.94	3.32
October	1,032,244	40,55	55.67	1.62	9.74
November	1,061,422	78.47	100.70	4.44	20.23
December	1,129,065	127.43	157.05	6.23	22.23
1918					
January	1,096,434	147.91	161.38	4.51	30.78
February	1,095,039	101.43	78.15	2.18	18.32
March	1,129,223	224,48	117.47	2.91	19.05
April	1,168,558	366.74	106.18	3.31	16.97
May	1,197,757	102.36	56.97	1.79	6.39
June	1,303,746	42.50	37.69	1.27	4.48
July	1,328,513	34.76	33.57	.93	3.87
August	1,284,247	37.32	40.04	1.72	3.97
September	1,321,440	869.54	71.72	14.49	18.61
October	1,343,933	1,823.09	84.77	45.70	24.59
November	1,255,195	203.97	75.26	13.75	3.29
December	941,219	155.26	96.23	10.49	4.67
1919					
January	672,937	139.49	116.61	10.95	4.85
February	471,815	59.62	69.97	4.58	3.84
March	406,839	45.57	64.71	4.16	3.69
April	339,836	33.16	49.86	3.28	3.07
May	291,810	16.82	44.38	2.30	2.34
June	246,903	12.73	38.15	1.56	1.80
July	215,104	7.31	38.72	1.28	2.68
August	156,791	8.57	47.14	1.07	1.68
September	149,360	8.68	49.18	.80	.80
October	139,877	10.12	51.82	.60	.86
November	132,403	5.17	62.80	1.00	.45
December	135,441	5.05	67.25	.80	1.68

TABLE 16.—*Annual death rates per 1,000 strength, white enlisted men, in the United States, by months, from April 1, 1917, to December 31, 1919*

	Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia		Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia
1917					1918				
April	0.07	-------	0.46	1.63	September	41.72	0.03	5.19	7.12
May	.05	-------	.20	1.66	October	73.26	.02	14.16	8.25
June	-------	-------	.16	.54	November	6.88	.06	2.05	.75
July	-------	-------	.10	.16	December	5.58	.08	2.40	1.02
August	-------	-------	.06	.11					
September	-------	-------	.06	.17	1919				
October	-------	-------	.12	.86	January	4.96	-------	3.00	1.18
November	.01	0.01	.90	2.89	February	2.14	-------	1.02	.71
December	.14	.02	1.24	3.28	March	.91	-------	.68	.71
					April	.42	-------	.35	.32
1918					May	.21	-------	.29	.29
January	.22	.01	1.04	4.56	June	-------	-------	.24	.19
February	.07	-------	.42	1.99	July	.11	-------	.17	.22
March	.38	-------	.58	4.26	August	.08	-------	.31	-------
April	.45	.01	.79	3.38	September	.08	-------	.08	.17
May	.23	-------	.33	.98	October	.09	-------	.17	-------
June	.17	-------	.18	.49	November	-------	-------	.09	.09
July	.37	.01	.14	.41	December	-------	.09	.18	.35
August	.44	-------	.31	.52					

TABLE 17.—*Annual admission rates per 1,000 strength, colored enlisted men, in the United States, by months, from April 1, 1917, to December 31, 1919*

	Strength	Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia
1917					
April	4,870	24.63	56.66	2.46	12.32
May	5,826	16.46	96.72	2.06	10.29
June	5,171	2.32	13.92	2.32	9.28
July	6,675	12.59	23.38	----	3.60
August	8,519	2.82	18.31	----	19.72
September	9,409	11.48	21.68	1.28	20.41
October	21,795	15.97	35.79	2.75	21.48
November	39,225	26.31	56.90	9.18	75.25
December	36,851	50.80	126.67	18.56	116.25
1918					
January	50,705	87.81	124.03	6.63	89.94
February	49,955	70.87	90.32	6.97	58.38
March	54,814	257.01	209.50	12.04	103.55
April	59,015	269.02	246.85	13.62	120.38
May	87,650	108.01	166.48	13.01	81.20
June	89,305	30.24	50.93	4.17	27.28
July	124,976	25.54	83.06	4.61	32.46
August	168,422	51.44	93.98	5.56	46.81
September	164,846	713.91	109.49	22.57	50.74
October	182,705	1,372.54	56.02	85.65	70.74
November	150,587	79.94	51.16	16.10	25.66
December	104,140	78.12	69.26	16.83	27.20
1919					
January	68,337	86.76	103.09	19.14	27.40
February	66,104	49.74	74.07	12.71	27.23
March	44,634	30.38	65.86	12.63	25.27
April	29,824	16.90	47.89	4.83	10.46
May	20,780	19.05	44.45	3.46	5.77
June	18,562	12.28	37.49	5.17	10.34
July	20,058	8.37	68.80	7.18	28.11
August	18,013	4.66	21.32	2.00	2.00
September	11,322	5.30	32.84	----	1.06
October	9,084	1.32	27.74	----	1.32
November	8,792	----	34.10	1.36	4.09
December	8,935	1.34	48.33	----	12.08

TABLE 18.—*Annual death rates per 1,000 strength, colored enlisted men in the United States, by months, from April 1, 1917, to December 31, 1919*

	Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia
1917				
April	----	----	2.46	2.46
May	----	----	----	----
June	----	----	----	----
July	----	----	----	1.80
August	----	----	----	1.41
September	----	----	----	2.55
October	----	----	.55	2.20
November	----	----	1.22	9.18
December	----	----	1.30	20.84
1918				
January	----	----	2.13	13.97
February	0.24	----	1.68	8.89
March	.44	----	3.94	22.33
April	1.63	----	5.08	27.45
May	.27	----	2.74	13.56
June	.27	----	.54	4.17
July	.38	----	.77	4.80
August	.93	----	.93	8.27
September	35.01	0.07	7.28	11.50
October	66.14	----	22.20	23.32
November	1.51	----	2.15	2.71
December	1.27	.23	2.19	3.23
1919				
January	1.76	----	2.99	3.34
February	.55	----	.91	3.27
March	.81	----	2.69	1.88
April	----	----	----	1.61
May	.58	----	.58	.58
June	----	----	----	1.94
July	----	----	.60	1.20
August	----	----	.67	----
September	----	----	----	1.06
October	----	----	----	1.32
November	----	----	1.36	----
December	----	----	----	----

TABLE 19.—*Annual admission rates per 1,000 strength, white enlisted men in Europe, by months, from June, 1917, to December 31, 1919*

	Strength	Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia
1917					
June, and preceding	13,420	9.84	8.94	1.79	3.58
July	28,821	15.82	34.97	1.67	4.58
August	50,882	19.10	35.14	1.89	.94
September	70,266	23.74	38.42	1.54	2.22
October	92,139	58.35	84.79	5.60	4.30
November	123,429	146.12	153.02	4.57	7.78
December	160,178	172.46	219.21	5.69	9.81
1918					
January	193,264	96.80	92.52	4.84	15.34
February	223,130	57.60	46.68	1.77	5.65
March	283,268	66.55	44.44	3.26	11,27
April	388,048	66.39	33.27	1.70	7.45
May	587,240	79.37	24.46	1.06	5.01
June	796,427	83.73	14.89	1.10	2.98
July	1,063,192	45.84	9.76	.77	2.57
August	1,266,592	56.41	12.35	1.72	2.66
September	1,527,793	214.90	27.77	12.04	9.09
October	1,635,321	315.04	43.84	23.58	14.54
November	1,682,836	146.82	41.59	7.49	4.76
December	1,591,962	136.07	59.32	6.96	5.56
1919					
January	1,488,683	102,44	56.45	7.63	4.80
February	1,310,083	137.20	65.12	12.50	8.66
March	1,115,693	58.26	41.18	5.24	3.60
April	853,425	30.36	29.04	3.21	3.23
May	569,842	18.76	16.83	1.92	2.17
June	271,633	11.97	15.24	1.06	1.86
July	111,634	17.41	23.65	.75	4.51
August	48,006	15.00	54.74	2.00	4.50
September	30,315	15.04	27.32	2.77	3.56
October	21,055	18.23	64.96	3,99	1.71
November	18,920	10.78	110.34	2.54	5.07
December	18,379	90.08	267.62	9.14	4.57

TABLE 20.—*Annual death rates per 1,000 strength, white enlisted men in Europe, by months, from June, 1917, to December 31, 1919*

	Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia
1917				
June and preceding				0.89
July			0.42	.42
August			.24	
September				.17
October			1.17	.65
November			.97	.97
December	0.22	0.22	1.12	1.20
1918				
January	.25	.25	.99	2.11
February		.16	.32	1.08
March	.13	.04	.30	1.53
April	.15		.06	.68
May	.16	.12	.06	.57
June	.24	.05	.09	.38
July	.25	.03	.09	.41
August	.83	.05	.42	.72
September	12.05	.59	4.45	3.96
1918—Continued				
October	18.04	.68	8.64	6.16
November	3.17	.46	1.36	1.20
December	2.19	.32	.93	.98
1919				
January	2.39		2.18	.98
February	4.19		2.94	2.05
March	.83		.86	.54
April	.30		.31	.32
May	.11		.21	.15
June	.09		.13	.49
July	.11		.11	.75
August			.50	.25
September				
October	.57			
November				.63
December	3.26	1.31	1.31	1.31

TABLE 21.—*Annual admission rates per 1,000 strength, colored enlisted men, in Europe, by months, from November, 1917, to September 30, 1919*

	Strength	Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia
1917					
November	2,392	125.63	572.86	20.10	15.08
December	5,346	159.19	426.01	22.42	125.56
1918					
January	8,673	361.00	278.01	23.51	307.05
February	9,664	196.27	268.32	18.63	137.89
March	11,541	225.57	291.06	23.91	185.03
April	12,667	312.50	227.27	7.58	115.53
May	28,279	224.38	117.10	8.06	72.13
June	33,208	104.45	104.45	7.59	49.15
July	47,171	80.13	55.46	6.36	47.32
August	78,734	73.77	27.13	5.94	23.78
September	91,270	332.63	56.93	32.08	51.41
October	138,827	288.01	35.18	38.12	47.20
November	148,679	194.51	31.72	16.30	29.54
December	148,372	171.63	48.69	17.87	28.07
1919					
January	140,396	154.02	43.25	17.86	26.50
February	131,219	156.10	68.50	22.04	36.95
March	123,152	95.29	41.02	8.67	15.40
April	119,801	64.31	43.27	8.81	13.12
May	108,650	23.53	33.24	3.98	8.17
June	64,166	21.69	30.11	3.18	10.66
July	12,508	16.31	47.02	3.84	9.60
August	1,714	6.90	62.07	----	13.79
September	1,287	9.35	18.69	9.35	----

NOTE.—No rates given when strength less than 1,000.

TABLE 22.—*Annual death rates per 1,000 strength, colored enlisted men in Europe, by months, from November 1, 1917, to September 30, 1919*

	Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia		Influenza (all)	Bronchitis	Broncho-pneumonia	Lobar pneumonia
1917					1918—Continued				
November	----	----	----	----	November	4.68	.24	2.34	4.52
December	----	----	2.24	29.15	December	3.80	.24	2.35	4.13
1918					1919				
January	----	4.15	1.38	45.64	January	2.99	----	3.59	4.19
February	----	1.24	2.48	16.15	February	3.29	----	2.93	6.13
March	----	2.08	1.04	30.15	March	.88	----	.97	1.56
April	0.95	1.89	----	12.31	April	.29	----	1.10	1.00
May	1.27	.85	.85	5.09	May	.10	----	.11	.88
June	.72	----	.72	7.23	June	----	----	.75	.75
July	.51	.25	.25	5.09	July	.10	----	.96	----
August	.91	.30	.91	5.33	August	----	----	----	----
September	23.53	1.05	8.68	17.22	September	----	----	----	----
October	21.09	.95	12.37	16.34					

NOTE.—No rates given when strength less than 1,000.

Chart VIII shows that the admission and death rates were both high for white enlisted men in the United States in April, 1917; not as high as in the subsequent April, but in relation to the low rates of the following summer, the difference is almost as marked. Was this high point due to influenza at that early date, or was it merely an unusual seasonal prevalence of respiratory disease? The colored troops had the same high point at this time, and it is to be remembered that in April, 1917, the number of recruits in the Army was comparatively small; in the main it consisted of seasoned troops. Consequently any considerable rise in rates at this time is of more significance than would be the case had a large proportion of recruits recently joined. The case fatality

rate for white enlisted men at this time was exceeded only twice in the subsequent months, during the great wave of the fall, and in the first recurrence thereafter. It seems justified to conclude that we have here fairly definite evidence to the effect that the influenzal infection was then at work among the troops. The first recognizable wave then during the war period occurred in the first month shown in the statistics. Following this wave there was a sharp drop to a level lower than ever subsequently reached during the war. The next well-marked rise reached its height in December, 1917, and January, 1918, varying somewhat with different localities, the total figure highest in January for admissions and deaths in this country and for admissions in Europe. The peak month for deaths at this time in Europe was December.

The month of February showed a well-marked decline in the rates for all groups, to be followed by a third and, in this country, much higher peak in March and April, deaths higher in March and admissions in April. This wave shows on the curves for troops in Europe, but not nearly as sharply as in the United States. The admission rates rise slightly in March and then fall very slowly for the succeeding months, apparently continuing high through June. This was the period of the type of influenza known to the American Expeditionary Forces as "three day fever." Except in the first month it was accompanied by relatively little mortality. The next rise shown is that culminating in the great October peak. There is in all groups studied a higher admission and death rate for respiratory diseases in August than there was for July. This is a significant phenomenon taken in connection with the fact that August is usually expected to show the lowest rates for these diseases of the entire year. In the colored troops in the United States this rise is seen to begin a month earlier still, or in July, 1918. At this time, a large number of cases of rather fatal lobar pneumonia were noted in this race in widely scattered camps. It seems probable from the progressive character of the subsequent rise in the rates that these cases represent the earliest of the great wave, occurring in the most susceptible group in the Army. The case fatality for white troops also showed a rise in the month of July and progressively continued into the high point of the fall wave. To determine the actual time of beginning of the rise for this wave recourse is had to a compilation of the weekly telegraphic reports of current medical statistics. Though these are not satisfactory for the purpose of estimating the total number of cases, they do show well the comparative numbers from week to week. Influenza was not on the list of diseases of which weekly reports were required at that time, and so the compilation includes only those stations that did report the disease. The data are assembled in Table 23. There is seen to be a progressive increase in cases reported as influenza beginning with the week ending August 4, 1918, and of the influenzal pneumonia cases beginning with the week ending August 18 of that year. If this was really the beginning of the great epidemic wave we should expect that if these series of data were plotted out on a logarithmic scale the increase from week to week would plot out as a straight line following the usual logarithmic rise of an epidemic curve. That this condition is substantially fulfilled is seen in Chart XIV.

TABLE 23.—*Incidence of influenza and of influenzal pneumonia, by weeks, June 17, 1918, to December 29, 1918. Annual admission rates per 1,000 strength*

Week ending—	Influenza	Influenzal pneumonia	Week ending—	Influenza	Influenzal pneumonia	Week ending—	Influenza	Influenzal pneumonia	Week ending—	Influenza	Influenzal pneumonia
June 23	167.7	20.1	Aug. 11	183.8	12.4	Sept. 29	1,700.0	85.2	Nov. 17	570.0	24.3
30	185.0	18.7	18	206.4	13.5	Oct. 6	1,702.0	77.0	24	653.0	27.4
July 7	153.2	14.4	25	270.0	17.5	13	1,565.0	74.7	Dec. 1	769.0	32.8
14	171.6	15.5	Sept. 1	408.0	24.7	20	1,880.0	86.5	8	800.0	34.4
21	155.9	13.0	8	467.0	26.9	27	1,351.0	61.1	15	914.0	38.8
28	134.0	13.9	15	683.0	38.4	Nov. 3	1,248.0	55.4	22	647.0	28.4
Aug. 4	173.2	12.5	22	1,097.0	56.5	10	816.0	35.9	29	506.0	22.3

It is evident that both in this country and in Europe the rates for respiratory disease began to rise at least as early as the month of August and that the rise was practically simultaneous in the two forces, separated by thousands of miles of water. That an epidemic wave once developed is spread by contact of cases, is of course, incontrovertible. But that the widespread, practically simultaneous, increase in the rates that was observed not only with this wave but also with all the preliminary and recurrent waves of the pandemic could have been accounted for by transmission from case to case of a common source seems incredible.

The rise for the October peak, then, began about the first of August; the decline after the peak was prompt, but the admission rates remained relatively high during the winter of 1918–19, though not in this country or in Europe equaling the rates observed for the previous winter. There was, in January and February, evidence of a recurrent wave that affected the troops both in this country and in France, the peak abroad coming somewhat later than that here. The fatality of this recurrence was lower in this country than it was abroad, as indeed was the case with the peak wave of October. There is also definite evidence in all the charts of a distinct minor increase of activity of the influenza virus in the months of June and July, 1919. This is reflected to some extent in almost all the rates, but shows most distinctly in the admission rates of the colored troops and in the case fatality in the whites, thus harmonizing with the reaction of seasoned troops of those races to the action of the disease. The final wave shown during the arbitrarily limited period of this study is the beginning of the so-called 1920 recurrence, which reached its height in January and February of that year, but is distinctly shown on the charts in its incipiency in December, 1919.

It appears from this summary that evidences of epidemic waves of influenza during the war period were noted for: (1) April, 1917; (2) December, 1917, to January, 1918; (3) March to April, 1918; (4) September to October, 1918; (5) January to February, 1919; (6) June to July, 1919; (7) The beginning of of the 1920 recurrence observed in December, 1919.

Of these waves, the first, second, fourth, sixth, and seventh (culminating as it did a couple of months later) fall at intervals that coincide very well with the 33-week period of influenza pointed out by Brownlee.[9] The third and fifth waves, which do not fit into this scheme, also fall about that time apart. The Army Medical Department statistics of the World War are not particularly

well adapted to the study of periodicity in its most exact form, since these statistics cover too large an assemblage of widely separated units; however, the the distinct approximation to the period of Brownlee is of more than passing interest. The point of greatest importance to be brought out at this time is the very evident fact that the time relations of the various waves described in

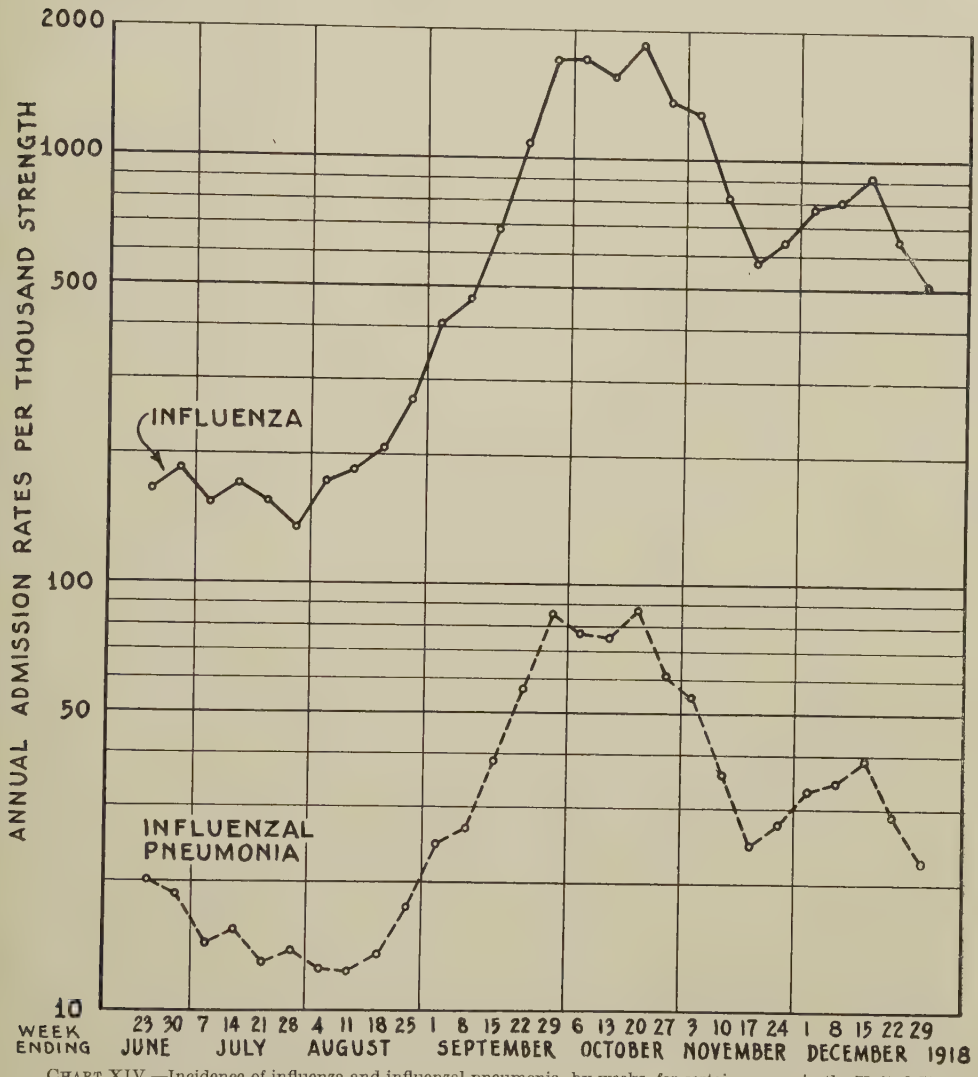
2000
1000
500
100
50
10
ANNUAL ADMISSION RATES PER THOUSAND STRENGTH
INFLUENZA
INFLUENZAL PNEUMONIA
WEEK ENDING
23 30 7 14 21 28 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 1 8 15 22 29
JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER 1918

CHART XIV.—Incidence of influenza and influenzal pneumonia, by weeks, for certain camps in the United States, June 17 to December 29, 1918. Annual admission rates per 1,000 strength based on weekly reports of current medical statistics

the troops at home and abroad seem to preclude the idea of the transmission of these waves from one command to another. The peak months varied in some instances but the evidences of the beginning of the rise for each wave were usually coincident in the two groups. This observation is of fundamental importance in the epidemiology of the disease.

Epidemiologists have usually approached the study of epidemic influenza from the point of view that the disease had originated in some distant land and reached any given point by certain fairly definite routes. The Medical Department figures, as summarized above, show that the fatal wave of the fall of 1918 was preceded by several preliminary outbreaks, and followed by a number of recurrences, and that the rates of incidence and mortality for widely separated commands were so nearly synchronous in their rise and fall for each wave as to impress the student with the probability that the virus of the disease had achieved a world wide distribution months before the mortality records forced recognition of its prevalence. It must follow from this observation that the disease once established in a community passes through alternating phases of increasing and decreasing activity, due either to changing qualities of the virus itself or to variations in the susceptibility of the population. And here again we are led to speculate as to the possibility that this disease may in fact be constantly present in all populations, making its presence felt only through cases of such mildness as to attract little attention unless such cases are indeed the usual predisposing condition needful for the production of the endemic pneumonias of the interepidemic periods.

COMPARISON OF ARMY AND CIVIL DEATH RATES

The high incidence and mortality from pneumonia in the earlier days of mobilization, together with the explosive character of the fall epidemic (1918), as it appeared in the camps in this country, with the appalling number of deaths concentrated in a very few weeks in each camp, have led to the idea that the death rate from respiratory disease was enormously higher in the Army than was the case in civil life. While this was true, to some extent, especially as regards the newly recruited troops in the camps in this country, it is believed that the actual figures do not bear out the general impression. The closely knitted communities of the camps afforded the greatest opportunity for the epidemic to spread, but while the rates in these camps were higher than those of civil life, they were not as high as some apparently have believed.

The comparison of death rates in the Army and in civil life is rather a complicated matter and many factors must be taken into consideration before fairly comparative figures can be adduced. In the first place, the usually published rate for a civil community is a gross one, taking into consideration no difference in the specific rates for race, age, and sex. The Army rate, on the contrary, is based on a population exclusively male and of an age grouping quite different from that of a civil community. For present purposes it may fairly be assumed that for the period of greatest mortality during the World War the proportion of colored and white troops in the service was the same as that in the corresponding age groups of the general population. In order to make a comparison, then, it becomes necessary to apply the specific rates for the various age groups of males in the civil population to the strength of the corresponding age groups in the Army, and to compare the number of deaths thus arrived at with the number that actually occurred in the military service. For the purpose of comparison, the year 1918 has been selected, as this was the time of the greatest strength of the Army, also because for that period monthly figures are available on which to base the rate calculation for

the Army. These monthly compilations, however, have been made only for enlisted men in the United States and Europe and the comparison, therefore, is based on data which show a rate somewhat higher than that of the whole Army, which included officers, and also enlisted men in various tropical stations, both of which classes showed a decidedly lower death rate than did the enlisted men in this country and in Europe. Figures, by months, for the entire Army, however, are not available, and inasmuch as the figures used include the great majority of the Army, the comparison seems a fair one.

The proportion of men of different ages in the Army during the war is not a matter of direct record; however, from the records of the War Risk Insurance Bureau it is possible to show the ages of 3,673,125 men, obtained from their applications for policies of Government insurance. Since it is fair to assume that the average period of service was in the neighborhood of one year, and that the insurance policy was taken out at or near the beginning of the service period, the ages of these men have been advanced six months each to obtain an average figure for the war period. The following table shows the age grouping thus obtained.

Age group	Number of men	Percentage of total	Age group	Number of men	Percentage of total
15–19 years	138,267	3.76	35–39 years	54,975	1.50
20–24 years	1,644,952	44.80	40–44 years	24,975	.68
25–29 years	1,345,679	36.60	45–49 years	9,990	.27
30–34 years	448,631	12.20	50–64 years	5,656	.15

It is believed that these figures are fairly representative of the actual conditions, although the fact that officers as well as enlisted men are included somewhat increases the percentage of the older age groups.

It has been shown that when the strength of a command varies greatly from month to month, and at the same time the death rates vary greatly, a death rate based on the total number of deaths for the year and the mean annual strength will not give a figure fairly comparable to that of a command of nearly uniform strength having the same monthly death rates.[10] If it happens that the months of greatest strength are also those of the highest death rates, the effect on the annual death rate, calculated as above stated, is to make it too high, while, if the high death rates coincide with a period of low strength, the rate will be too low as compared with a command of uniform strength having the same monthly rates. The average of the monthly rates for the year, however, gives a truly comparable figure whatever variations there may be on the part of the strength or of the monthly death rates. In comparing the military and civil rates, then, it is important to take this factor into consideration, for while the Army increased to a maximum strength in the months of the highest death rates due to the influenza epidemic, the number of males of military age who remained at home and contributed to the civil death rates correspondingly diminished. These fluctuations were great enough to have a very marked effect on the rates. The rates for months but not by age groups are available for the Army. The rate for the age groups but not by months are available for the civil population (registration States). Hence some method must be devised to reduce the two sets of data to a common basis.

The average of the monthly death rates from disease of all kinds for enlisted men in the United States and Europe was 16.1 per thousand.[1] The total number of deaths from disease was 44,924.[1] If this total number of deaths during the year be divided by the death rate and multiplied by one thousand it will give a figure representing the strength that would have given the same number of deaths during the year had the strength and the death rate remained uniform throughout the year. The figure in this case is 2,788,000. This is an average of the monthly strengths weighted by the death rates for the corresponding months. For the reasons given above this is the best figure to use for the average strength of the Army when comparing its rates with those of the civil population.

The next factor to be estimated is the proportion of the various age groups of the male population as estimated for 1918 that were not in the services (Army, Navy, and Marine Corps) and so remained to contribute to the civil rate. The usual arithmetical method of estimating population based on the census returns of 1910 and of 1920 can not be applied to the years previous to 1919 without taking into consideration the excess deaths in the various age groups due to the influenza epidemic and to battle casualties. If these be estimated as carefully as possible and added to the population as found in 1920 the estimate for 1918 becomes satisfactory. If, then, from the population of each age group, as thus estimated, is subtracted the number of men of each age in the service the remainder will represent the number in each age group that contributed to the civilian death rates. It is estimated that the Army represented 87.5 of the total military forces during the war, the balance being the Navy and the Marine Corps. Hence the weighted mean strength of the services during 1918 was 3,180,000 men. The registration States furnished 76.51 per cent of this total or 2,435,000. If these men be divided into age groups according to the percentages shown in the table of ages the results will represent the number of men in each age group furnished to the services by the registration States. These numbers subtracted from the estimated population of the registration area in each group will give the civil population in each group during 1918, and from these last figures the death rates for each group may be calculated from the number of deaths in each group in the registration states as furnished by the Census Bureau. The following specific death rates from disease for males of the indicated age groups were arrived at by the method given.

Age	Death rate from disease	Age	Death rate from disease
15–19 years	7.05	35–39 years	14.12
20–24 years	13.18	40–44 years	13.23
25–29 years	17.50	45–49 years	14.03
30–34 years	17.78	50–64 years	22.58

If these rates are applied to the weighted mean strength of the Army and the latter divided into age groups according to the age table given, the total result is 42,184 deaths, or 15.1 per thousand on the weighted mean strength.

The comparative rate for the Army as given above was 16.1, a difference that, if occurring from one year to the next in the same population, would not be regarded as highly significant.

When, however, the rates for the total respiratory diseases are treated in the same manner the rates obtained are 12.59 for the Army and 9.96 for the civil population. It is evident that the Army had a decidedly higher reported death rate for the respiratory diseases than was found in civil life and equally evident that the reverse was true for other causes of death. In fact, the figures indicate that at civil rates the Army would have lost nearly seven thousand more men than was actually the case from causes other than the respiratory diseases.

The reasons for these differences are probably several. It will be shown later that men from rural districts, when introduced into the conditions of barrack life, are much more susceptible to respiratory infections than are their urban brethren. Urban rates for respiratory diseases are always markedly higher than those of rural districts. In the Army hundreds of thousands of young men from rural districts were living in the Army camps in conditions of closer contact than in ordinary city life. The majority of these men in this country at the time of the great epidemic were comparatively new to the service, 76 per cent had seen less than four months' service,[a] and had little or no time for "seasoning." Certain cities in the country showed rates during the epidemic higher than those of the Army. For the last four months of 1918, had the rates that obtained in Philadelphia been applied to the Army strength there would have been 39,894 deaths from disease and 33,287 from the respiratory diseases as compared with 36,858 and 33,136, respectively, which actually occurred in the Army. Again, there is seen the greatly larger number of deaths from causes other than the respiratory diseases occurring in the civil population even during the epidemic months. So great a disparity suggests some differences in the standards of diagnosis in the two sets of figures. That many deaths occurring in the registration area were really due to influenza or pneumonia while otherwise reported, is suggested by the notable and unseasonable increases during the epidemic period in deaths from a number of other causes. It is undoubtedly true also that during this period, the country over, a great number of deaths occurred that were never reported. The conditions in many places were such that the keeping of accurate records was an impossibility. In the Army, however, every man had to be accounted for and the death records are as nearly accurate as it is possible to make them. It is to be recalled, too, that the Army rates as used in this comparison, excluded certain groups of the Army which showed a decidedly lower death rate than those given herein, and that the total rate for the Army would have been somewhat lower had the complete monthly figures been available for comparison. The conclusion seems justified, then, that the disparity existing between the two rates was not more than is accounted for by the assembling of large numbers of country boys in camps under urban conditions.

[a] Estimate made in manner described under "The effect of length of service in the Army," p. 90.

FACTORS TENDING TO MODIFY THE INCIDENCE AND MORTALITY OF THE RESPIRATORY DISEASES

In the following pages an attempt is made to glean from the available figures such facts as may show the effect of a number of varying factors on incidence and mortality of the respiratory group of diseases during the war. These varying factors have been considered in connection with different groups of the troops concerned, and the attempt finally is made to correlate the knowledge thus gained into a concrete conception of the pandemic as a whole; they include age, length of service in the Army, race, nativity, climate and weather, and housing.

AGE

As to the effect of age on the incidence of respiratory disease, we are able to present figures for deaths only, classified according to age.[1] These apply to the whole Army, wherever located, and include the deaths of officers as well as of enlisted men.

Deaths from influenza, bronchitis, and the pneumonias

Age group	Number of deaths	Per cent of total	Age group	Number of deaths	Per cent of total
Under 21 years	1,951	4.9	41–45 years	96	0.24
21–25 years	21,439	53.9	46–64 years	75	.19
26–30 years	13,310	33.4			
31–35 years	2,637	6.5	Total	39,827	100.00
36–40 years	319	.8			

If the above percentages be applied to the age groups as determined in the calculation of the relative death rates for the Army and for civil life and to a total of 37,002 deaths, the total for these diseases reported for 1918, the following rates per thousand per annum may be deduced.

Age	Death rates per 1,000 per annum	Age	Death rate per 1,000 per annum
Under 21 years	8.77	36–40 years	7.51
21–25 years	14.30	41–45 years	5.88
26–30 years	14.20	46–64 years	7.25
31–35 years	11.10		

These rates show nearly the same relations between the age groups as those published from civilian sources, though here the group 21–25 has a relatively higher rate than is usually given.

LENGTH OF SERVICE

It has long been known that men new to the military service are more liable to contract disease, especially disease of the classes under consideration, than are men long in the service. It is possible with the data at hand to present certain facts showing the degree of this increased susceptibility of the recruit.

The report cards of 34,446 deaths from influenza pneumonia show the length of service of the patient at the time of his admission to hospital.[1] Of

these deaths 9,847 or 28. 56 per cent occurred in men of less than two months' service, 10,990 or 31. 90 per cent in men of 2 to 4 months' service, 6,107, or 17. 73 per cent in men of 4 to 6 months' service, 2,629, or 7. 66 per cent in men of 6 to 8 months' service 1,663, or 4. 83 per cent in men of 8 to 10 months' service, 1,198 or 3. 48 per cent in men of 10 to 12 months' service, and 2,012 or 5. 84 per cent in men of over 12 months' service. These relations are graphically shown in Chart XV. It is impossible accurately to estimate the proportion of men of each service group in the Army for the entire period of the war, inasmuch as the proportion was constantly changing with the passage of time; however, an attempt has been made to average the proportions found in different months. The resulting relative strengths probably approximate the distribution of men at the time of the greatest mortality in the fall of 1918. Based on these relative strengths, rates have been calculated showing the relative differences in death rates of the different length of service groups; these are given in Chart XVI and show the same general relations as Chart XV. The former gives a better relative idea of the importance of short service as a cause of death. It is seen that 60.46 per cent of all deaths occurred in soldiers of less than 4 months' service. It is to be noted also that the second bimonthly period shows a larger proportion than does the first. This is an unexpected finding and may be due to other factors than increased incidence among the men concerned.

It is obvious that if there had happened to be an unusually large proportion of men of the two to four months' group service in the Army at the time of the fall wave (1918) of influenza, and a correspondingly small number of men of less than two months' service, the number of deaths charged to the latter group would be relatively small in the total and those of the former would be too large. The same principles apply as to the estimation of death rates in commands of varying strength. As a matter of fact the number of two to four months' men was considerably larger in September and October, 1918, than was that of the less than two months' service men. This conclusion has been arrived at by studying the relations of the total enlisted strength of the Army from month to month. Thus, if the total strength was greater by 200,000 one month than in the month previous there must have been in that month 200,000 men of less than one month service. This gives us means of checking up on the figures already given. It is available only during the period of progressive increase in Army strength, and takes into account no losses from death or discharge, but it is believed that it is roughly satisfactory as a check. If the number of men of less than two months' service in each month from October, 1917, to October, 1918, inclusive, be compared with the total enlisted strength in the United States the same month, the percentage of recruits of that length of service may be obtained for each month. If, then, for each month the corresponding percentage of deaths among enlisted men in the United States be calculated and the results added the sum shows the number of deaths that should have occurred among these men had their rate been the same as that of all the other men. This forms a certain percentage of the total deaths in the whole Army, in the case of the less than two months' service men, 20.45 per cent. As a matter of record, as has been stated, these men actually had

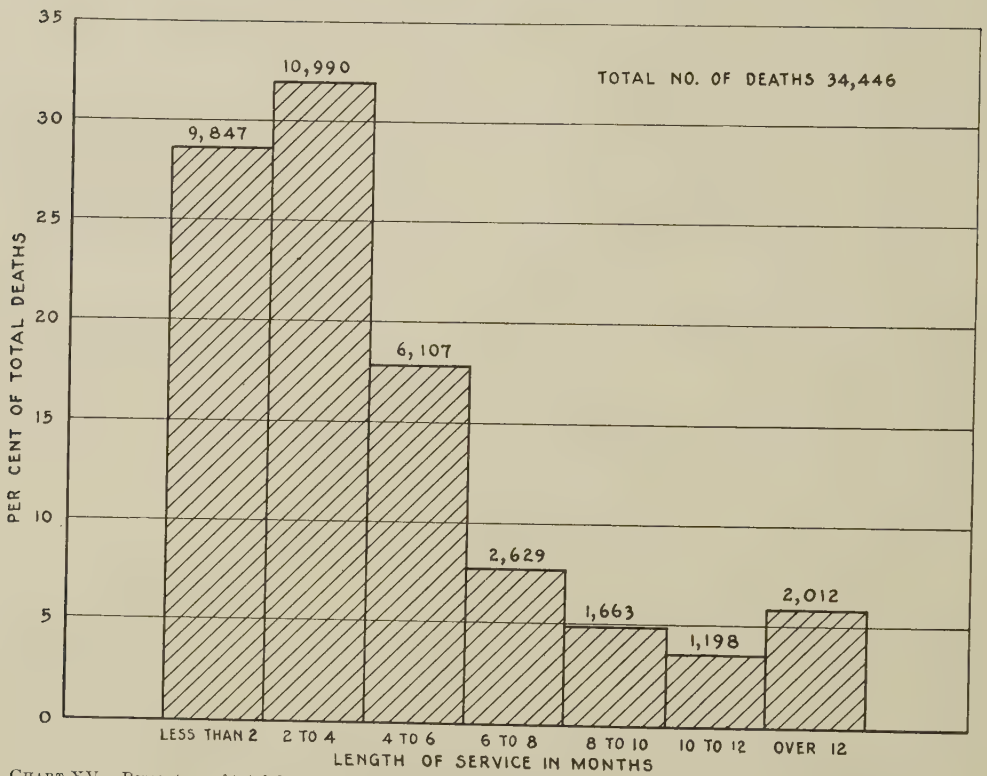

CHART XV.—Percentage of total deaths from influenzal pneumonia during the war period occurring in each of the specified groups of length of service

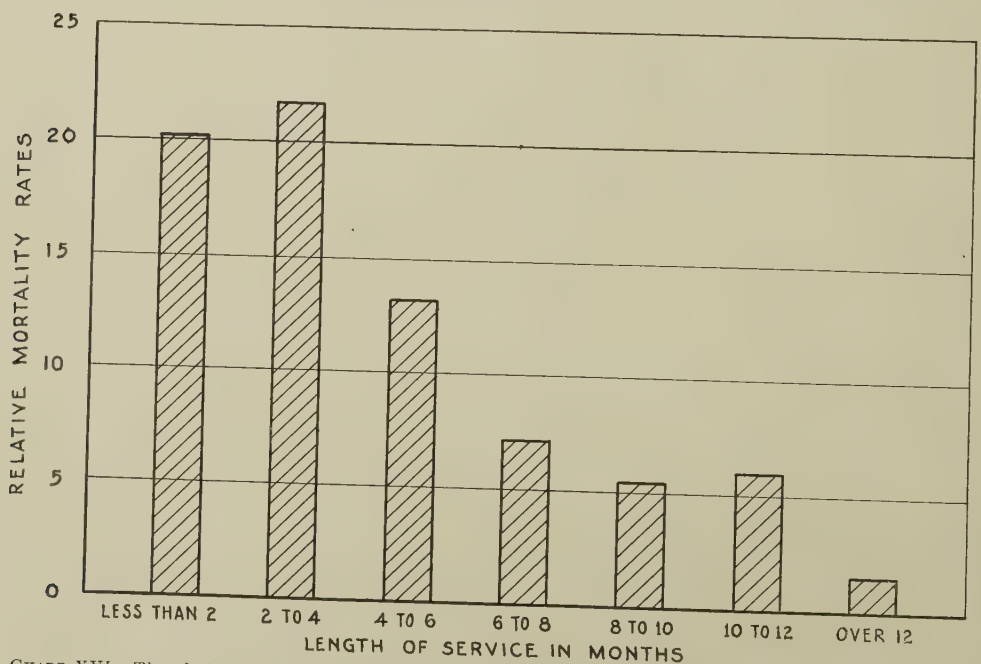

CHART XVI.—The relative mortality rates per 1,000 strength from influenzal pneumonia during the war period in each of the specified groups of length of service

28.56 per cent of the total deaths, or one and four-tenths times their pro rata share. Applying the same methods to the two to four months' men, it is found that their pro rata share was 12.83 per cent of the deaths, while the records charge them with 31.9 per cent, or two and forty-eight hundredths times the former figure. It is impossible to carry calculation to older service groups inasmuch as after four months' service considerable numbers began to go abroad, and the calculation of strength becomes less accurate. However, it is seen that the figures conform to those of the former series in showing that the man of two to four months' service apparently showed a higher mortality from respiratory disease than did those of less than two months. As stated above, there were about 30 per cent more men of the longer service group in the service during the fall outbreak of influenza than there were of the less than two months' service men. This undoubtedly is the factor increasing their rate in the total.

The unfavorable effect on camp rates of the presence of a number of recruits is mentioned in a large number of reports of the fall epidemic (1918).[11] Camp Sherman, Ohio, had the highest mortality rate of any large camp; 46 per cent of its strength were classed as recruits. The rate of Camp Cody, N. Mex., was almost as high, with 69 per cent recruits; Camp Grant, Ill., 40 per cent; Camp Forrest, Ga., 55 per cent; Camp Devens, Mass., 30 per cent; Camp Custer, Mich., 33 per cent; Camp Greene, N. C., 50 per cent; Camp Syracuse, N. Y., 90 per cent. In the lower part of the mortality scale are found Camp Travis, Tex., with 4 per cent recruits; Las Casas, Porto Rico, with 5 per cent; Camp Sheridan, Ala., with 6 per cent; Camp Eustis, Va., with 7 per cent; and Camp McClellan, Ala., with 10 per cent. If the larger camps be divided into four groups according to mortality, we find the group with the highest mortality had 41 per cent recruits, the second 31 per cent, the third 22 per cent, and the fourth 16 per cent. This relation is the most clean cut of any found among the factors influencing the comparative rates of the camps.

Many specific instances of the high mortality of new men as compared to those of longer service are on record. At Camp Grant, Ill., for instance, the September inductants lost 4 per cent of their strength, while the loss for the balance of the camp was less than 2 per cent. Vaughan said:[12] "If recruits had not been sent to Grant in September, the camp mortality rate from the epidemic would have been 1.7 per cent; 16,000 recruits raised the rate to 2.6 per cent an increase of 53 per cent."

The report of the influenza commission working at Camp Pike, Ark., showed similar relations, as follows:[13]

	Strength	Percentage of influenza	Percentage of influenza cases having pneumonia
Seasoned men	28,782	15.5	11.1
Recruits	23,749	30.6	13.9

At Camp Funston, Kans., the relations were as follows:[14]

	Admissions	Deaths	Ratio
Seasoned men	33.8	1.39	1.0
New men	30.3	2.29	1.65

From Camp Lee, Va., the following report was made:[14]

	Months service		
	Less than 1	1 to 3	Over 3
	Per cent	*Per cent*	*Per cent*
In camp	9.2	45.2	45.6
Epidemic deaths	30.1	46.2	23.7

At Camp Upton, N. Y., recruits were scattered among companies of the 2d Battalion in the proportion of three recruits to two older men, but no less than 167 recruits became sick before the first of the men who had been in camp prior to September 6.[14] Eight recruits died to each man of longer service.

Analysis of 494 cases of pneumonia made by the laboratory officer at Camp Grant, Ill., showed the distribution of cases as follows:[15] During the first month of service, 192; second month, 42; third month, 42.

A report from Camp Bowie, Tex., shows the large incidence of respiratory disease among recruits comprising a relatively small proportion of the strength of the camp, during the months of April, May, and June, 1918.[16]

At Camp Lewis, Wash., of 140 cases of pneumonia occurring during September, 1918, 107 were in men of less than one month's service and of 316 cases of influenza, the men of less than one month's service had 237.[17]

RACE

Of the various races shown in the general tabulations given herein, only the white and colored can be compared under corresponding conditions. The Philippine Scouts, the Hawaiians, and the Porto Ricans were so largely stationed in tropical or nearly tropical countries and in such comparatively small numbers that comparisons are of relatively little value. Suffice it to say that the Porto Ricans showed the highest admission rates for the total respiratory diseases of any group in the Army, while their death rate was well below the average.[1] The Philippine Scouts showed relatively low rates for admissions and deaths as compared to the Army as a whole, but had a higher admission rate and a very much higher death rate than those of the white enlisted men in the Philippine Islands.[1] The same general relations hold for the Hawaiians.[1] Owing to the effect of the favorable climate the mortality was not high but was higher in these native races than in whites living under the same conditions.

The comparison of the white and negro races, however, can be carried out under a great variety of conditions. The rates for admissions of the colored troops, as shown in the general tabulations, are higher than those for the whites

for every group except the troops in Hawaii. The death rates are higher in all cases, and usually very much higher. Thus the case fatality of the colored is seen to be much higher than was the case with the whites. More valuable deductions, however, may be made from the study of the monthly annual rates for admissions and deaths by races in the United States and Europe (see Tables 13–22). If the averages of the monthly annual rates in each group be taken for comparison it is seen that in the United States the total admission rate for respiratory diseases in the colored troops was slightly lower than that for the whites; however, this difference is due entirely to the small proportion of cases admitted with a primary diagnosis of influenza. The cases showing respiratory symptoms more markedly, the bronchitis and the pneumonias all showed a higher rate for the colored than for the white. It is possible that the colored recruit was slower on the average in reporting his illness, but inasmuch as the total figure is practically the same as that of the white the more probable explanation would seem to be that when attacked, the colored man averaged a much more severe case than did the white man. In Europe the colored troops showed an admission rate over double that of the whites for the same period and much higher than that of the colored troops in the United States. The highest admission rates then were those of the colored troops in Europe, followed in order by those of the colored troops in the United States, the white troops in the United States and the white troops in Europe. The rates of the latter are probably given too low in the tables quoted inasmuch as a considerable number of cases of respiratory disease were reported under the heading "Color not stated," somewhat over 24,000 in all, most of which occurred in Europe during the months of September and October, 1918. The comparison of the case fatalities of these cases and of the relative proportion of lobar to bronchopneumonia leads to the conclusion that most of these men were white. However, if all of these were added to the white admissions the relations would not be very materially changed and it has seemed better to deal with the figures as shown.

The relations between the death rates of the different groups is somewhat different. Here the highest average rate is that of the colored troops in the United States, 16.06 for the months covered by statistics for the colored in Europe. During the same period the colored troops in Europe showed a death rate of 11.78 per thousand per annum. For the 31 months for which we have figures for the white troops in Europe their rate was 3.72 as compared to 7.16 for the whites in the United States for the same months. Reverting to the effect of length of service then, it appears that while the seasoned white soldier shows to marked advantage both as to admission and death rates compared to the recruit, the effect of seasoning on the colored soldier is much less marked, and indeed under the conditions he was called upon to face in Europe his admission rate was higher than that of the relatively untrained men in this country. The seasoned colored soldier, however, did show a small gain in the matter of deaths, though even here the difference is by no means so marked as is found in the whites. The effect on case fatality of length of service as deduced from the figures for the troops in Europe and in the United States, is to increase the

figure for the white troops and to decrease it for the colored. It is to be remembered that these conclusions are drawn from the averages of monthly annual rates and not from the total group figures shown in general tabulations. For reasons already explained this method is believed to give the more reliable results.

While, as has been stated, the admission rates for the colored troops averaged slightly lower than those for the whites in this country for the period of the war, it is noticeable that this was due not only to a relatively small number of the milder cases but was influenced as well by the stage of evolution of the pandemic. Previous to the fatal wave of September and October, while the virus may be assumed to have been gathering virulence, the rates for the colored troops are shown to be decidedly higher than those for the whites. During the peak wave the whites showed more cases, and following this the two curves remain much closer together, the differences being hardly significant until a point well on in 1919 when the short-lived immunity conferred by the disease had begun to wear off. The colored rate then again began to rise above that of the whites.

In other words, the colored soldier is seen to have been relatively more susceptible to the infection in that he contracted it in larger proportions in the preliminary waves, thus acquiring an immunity that served to protect him against the more fatal wave which followed. A somewhat similar relation is to be noted between the white soldier of the North and of the South, as will be brought out later.

Another point in which interesting racial differences are shown by the figures is the relative proportion of bronchopneumonia to lobar pneumonia. It is well known that clinically the differentiation between these two types of disease is not always possible. Confluent types of lobular pneumonia may produce physical signs indistinguishable from those of lobar consolidation. Even post-mortem examinations may leave one in doubt. However, as was pointed out in an earlier paragraph, it was noted early in the war period that a large number of cases of pneumonia presented clinically and anatomically the characteristics of bronchopheumonia rather than those of lobar type. Granting the impossibility of accurate differentiation in many cases, still it must remain true that in the observation of thousands of cases the figures obtained are significant and variations in the proportion of one type of pneumonia to another between different groups of soldiers, or from month to month in the same group, may prove to be important in the study of the effect of race and length of service.

Table 12 shows the ratio of bronchopneumonia to lobar pneumonia for the different subdivisions of the Army for the period of the war. These figures, like those for case fatality, are independent of any strength estimations and so are strictly comparable. They are, however, summation figures for the entire 33 months and hence, since the great majority of the cases and deaths occurred in September and October, 1918, they more nearly represent the values for those months than an average. These figures show that for the entire Army the pneumonia ratio for officers was 1.05, for the white enlisted men 0.76, and for

the colored enlisted men 0.42. For the Army in the United States the corresponding figures were 0.84, 0.61, and 0.39, while for the Army in Europe, 1.30, 1.19, and 49. It is seen that the values of these ratios correspond inversely in a general way with the relative resistance of the various groups, the officers suffering least from the epidemic, the white enlisted men next, the colored enlisted men having the greatest losses. It is also seen that the corresponding groups show a higher ratio in Europe than in this country.

STATE OF NATIVITY

Figures are available showing the number of admissions and deaths from all the respiratory diseases according to the State of birth of the patient as given by him at the time of his admission into the hospital.[1] From these it is possible to calculate directly the case fatality by States. The question of calculating rates of incidence and mortality from these figures is complicated by the fact that we have no knowledge of the number of men born in each State who served in the Army. Comparative rates have been published based on the total inducted strength from each State and probably in many cases this results satisfactorily. However, such rates take no account of foreign-born inductants, of whom there was a large number from some States, nor of the effect of migration from State to State. Certain of the Western States showing very low rates when treated in this way can be shown to have had in 1918 over three times as many men of military age as there were children 18 years younger in 1910. A similar effect on the rates is produced by the presence from a State of a large proportion of foreign-born inductants. Manifestly the excess is the result of immigration, and to base nativity rates on such an increased number of men results in a rate far too low. The reverse is true of States losing population by emigration. In order to obtain figures on which it might be possible to base comparisons of incidence, it seems best to prorate the inducted strength of the Army between the States in the same proportion as the States had boys under 10 years of age in 1900. This should result in a fair approximation to the number of men born in each State who served in the Army. Inasmuch as this method takes no account of the foreign-born soldiers the rates are of value only for comparisons between themselves. The method should allow us to state that the death rate in natives of one State was higher than in natives of another, but it does not permit of comparisons with other rates based on more complete data. Table 24 shows the number of admissions and deaths for total respiratory disease by native State for white enlisted men with rates calculated according to the method described, and the case fatalities. In the first column of Table 25 the States have been arranged in the order of incidence rates for white enlisted men beginning with the State having the lowest rate, while the second column shows the order with respect to mortality and the third case fatality. It is seen that there is a general correspondence between the two columns, though some differences are noted.

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TABLE 24.—*Relative admission and death rates, and case fatality for the respiratory group of diseases for white enlisted men, United States Army, by State of birth*

State	Admissions	Rate	Deaths	Rate	Fatality
Alabama	18,348	312.2	545	9.29	2.97
Arizona	1,061	194.3	30	5.49	2.83
Arkansas	18,046	340.3	506	9.46	2.82
California	15,481	330.0	415	8.12	2.68
Colorado	6,032	270.0	261	11.70	4.33
Connecticut	8,349	242.0	311	9.02	3.73
Delaware	1,387	182.0	35	4.59	2.53
District of Columbia	1,644	183.2	67	7.46	4.08
Florida	7,319	453.0	282	17.45	3.85
Georgia	18,955	276.0	613	8.92	3.23
Idaho	1,964	240.0	67	8.19	3.41
Illinois	53,876	252.5	1,973	9.25	3.67
Indiana	29,301	273.0	992	9.26	3.38
Iowa	30,548	300.0	1,309	11.81	3.86
Kansas	23,451	349.2	937	13.95	3.99
Kentucky	18,208	189.0	920	9.55	5.05
Louisiana	14,800	339.5	596	13.67	4.03
Maine	6,871	281.5	292	11.97	4.25
Maryland	10,591	248.0	387	9.05	3.66
Massachusetts	24,870	236.5	928	8.82	3.73
Michigan	23,886	233.2	955	9.22	3.95
Minnesota	22,692	260.4	1,127	12.92	4.96
Mississippi	13,865	329.5	454	10.79	3.28
Missouri	39,803	277.5	1,424	9.93	3.58
Montana	2,650	262.4	90	8.91	3.40
Nebraska	15,390	297.2	606	11.70	3.94
Nevada	562	389.0	30	20.78	5.34
New Hampshire	3,684	256.0	143	9.92	3.88
New Jersey	16,502	210.5	689	8.75	4.16
New Mexico	2,324	220.3	100	9.48	4.30
New York	62,508	218.0	2,250	7.85	3.60
North Carolina	18,267	248.5	626	8.51	3.43
North Dakota	4,163	236.9	201	11.51	4.83
Ohio	40,021	236.1	1,772	10.47	4.43
Oklahoma	12,907	287.3	394	8.78	3.05
Oregon	5,543	335.0	169	10.22	3.05
Pennsylvania	60,435	219.0	2,361	8.55	3.92
Rhode Island	3,312	202.0	129	7.87	3.90
South Carolina	9,558	274.7	360	10.34	3.77
South Dakota	6,554	316.6	322	15.57	4.91
Tennessee	20,399	219.8	784	8.45	3.85
Texas	49,324	347.0	1,417	9.98	2.87
Utah	3,963	254.0	165	10.58	4.16
Vermont	3,281	260.0	188	14.88	5.73
Virginia	16,457	254.7	595	9.20	3.62
Washington	6,056	280.2	178	8.24	2.94
West Virginia	14,240	284.0	530	10.55	3.72
Wisconsin	26,208	264.3	1,184	11.95	4.52

Charts XVII, XVIII, and XIX are outline maps of the United States showing the relative rates for admissions, for deaths and the case fatality of respiratory disease, the rates calculated as described above. The death rates in particular and to a lesser extent the admission rates are fairly consistent, in that neighboring States of similar topography and similar density of population show similar rates. The extremely high rates of Nevada and the low rates of Arizona and of Delaware were based on relatively much smaller numbers of cases than was the case for most of the other States and possibly are consequently less reliable. The fact, however, that in all three of these States the figure for the case fatality falls in the same relative position tends to strengthen the admission and death rates.

TABLE 25.—*Relative position of the States in respect of rates of natives for admissions, deaths, and case fatality from the respiratory group of diseases, white enlisted men, United States Army. Arranged in order from lowest to highest. The State showing the mean rate is italicized*

	Admission rates	Death rates	Case fatality
1	Delaware	Delaware	Delaware.
2	District of Columbia	Arizona	California.
3	Kentucky	District of Columbia	Arkansas.
4	Arizona	New York	Arizona.
5	Rhode Island	Rhode Island	Texas.
6	New Jersey	California	Washington.
7	New York	Idaho	Alabama.
8	Pennsylvania	Washington	Oklahoma.
9	Tennessee	Tennessee	Oregon.
10	New Mexico	North Carolina	Georgia.
11	Michigan	Pennsylvania	Mississippi
12	Ohio	New Jersey	Indiana.
13	Massachusetts	Oklahoma	Montana.
14	North Dakota	Massachusetts	Idaho.
15	Idaho	Montana	North Carolina.
16	Wyoming	Georgia	Missouri.
17	Connecticut	Connecticut	New York.
18	Maryland	Maryland	Virginia.
19	North Carolina	Virginia	Maryland.
20	Illinois	Michigan	Illinois.
21	Utah	Illinois	West Virginia.
22	Virginia	Indiana	Connecticut.
23	New Hampshire	Alabama	Massachusetts.
24	Vermont	Arkansas	South Carolina.
25	Minnesota	New Mexico	Florida.
26	Montana	Kentucky	Tennessee.
27	Wisconsin	New Hampshire	*Iowa.*
28	*Colorado*	Missouri	New Hampshire.
29	Indiana	Texas	Rhode Island.
30	South Carolina	Oregon	Pennsylvania.
31	Georgia	Ohio	Nebraska.
32	Missouri	*South Carolina*	Michigan.
33	Washington	West Virginia	Kansas.
34	Maine	Utah	Louisiana.
35	West Virginia	Mississippi	District of Columbia.
36	Oklahoma	North Dakota	New Jersey.
37	Nebraska	Colorado	Utah.
38	Iowa	Nebraska	Maine.
39	Alabama	Iowa	New Mexico.
40	South Dakota	Wisconisn	Colorado.
41	Mississippi	Maine	Ohio.
42	California	Minnesota	Wisconsin.
43	Oregon	Louisiana	North Dakota.
44	Louisiana	Kansas	South Dakota.
45	Arkansas	Wyoming	Minnesota.
46	Texas	Vermont	Kentucky.
47	Kansas	South Dakota	Nevada.
48	Nevada	Florida	Vermont.
49	Florida	Nevada	Wyoming.

Consideration of these figures shows that for the period of the war there was no such preponderance of disease and death from respiratory disease among the natives of the Southern States as was brought out by Vaughan and Palmer for the pneumonias of the early months of the mobilization.[18] In all three columns (Table 25) the States showing rates above the average (indicated by italics) represent practically every general section of the country. It is not noticeable, moreover, that the States with the largest cities tend to have lower rates in both admission and mortality columns. The relation between the three series of data is interesting. The variability of the rates is not the same. Of

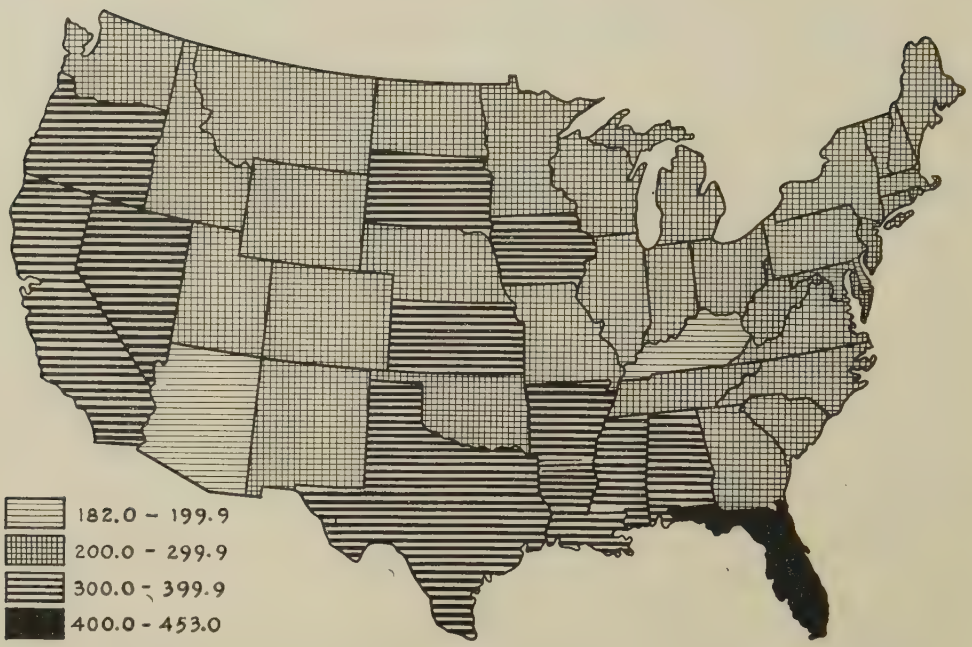


CHART XVII.—The relative admission rates for the respiratory group of diseases for white enlisted men by State of birth

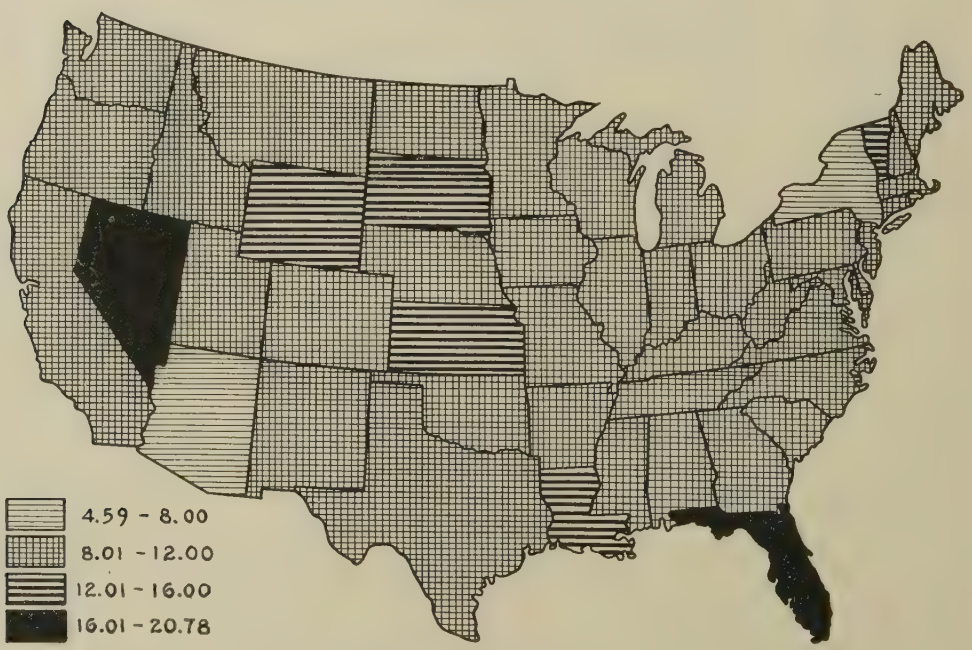


CHART XVIII.—The relative death rates from the respiratory group of diseases for white enlisted men by State of birth

the three series the case fatality shows the least variation between the States with a coefficient of variation of 0.16, admission rates were most variable, coefficient 0.26 and the mortality rates stood between with a coefficient of 0.20. It is evident that the mortality rate must bear a direct relation to both the admission rate and the case fatality. For the series as a whole the coefficient of correlation between the rates for admissions and for mortality is $+0.67 \pm 0.052$. This is a high correlation especially when the variability of fatality rates is considered. It is thirteen times its probable error. Of special interest is the fact, however, that the coefficient calculated for the death rate and the case fatality figures is practically identical, namely, $+0.677 \pm 0.052$. The influence on the death rate of the two factors, admission rates and case fatalities, was then about the same. This would be easily understood if the admission rate and the

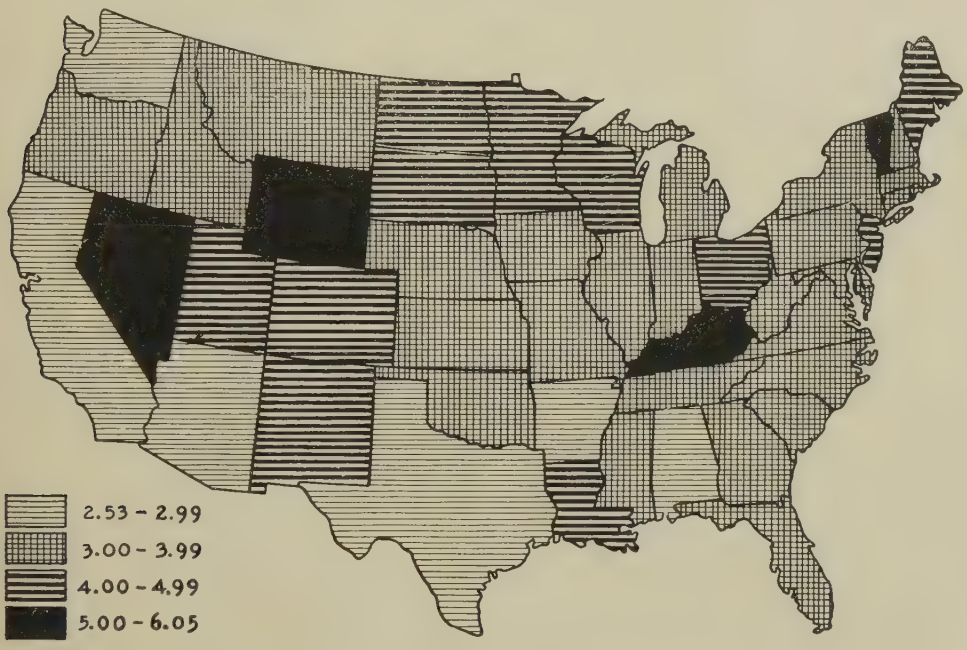


CHART XIX.—The case fatality rates (per cent) of the respiratory group of diseases for white enlisted men by State of birth

case fatality could be referred to the same set of cases. That this is improbable, however, is shown by the fact that there is no correlation between these two series of rates. The coefficient of correlation between the admission rates and case fatalities is -0.0962 ± 0.0955. The probable error is almost equal to the coefficient and the figure is entirely without significance. It appears then that two sets of causes, one affecting the admission rate or morbidity and the other the case fatality, were active in determining the differences in the death rates.

It is evident from study of the outline maps that neither Northern nor Southern States, Eastern nor Western, mountainous nor flat, showed any preponderance of either admissions, deaths, or case fatality. It has been a commonplace observation for years that when numbers of individuals were gathered together from various places and held under common conditions,

those from cities showed a lower rate of incidence from the sputum-borne diseases than did those from the rural districts. This has been noted especially for military concentrations of population but also has been shown to hold for students in universities and other similar assemblages. The reason for this presumably lies in the greater exposure to contact infection in the case of the city dweller, and the consequent development of an immunity specific or non-specific which tends to protect against invasion by the germs of disease. A comparison is possible between the rates of the different States and the relative urbanity of their population. The United States Census Bureau classes as rural all communities of less than 10,000 inhabitants. This figure is probably too high for the purposes of this comparison, but is the only one available for use. Taking the percentage of rural inhabitants of each State as given by the 1910 census, which is the median census for the average age for the troops involved, and comparing the figures thus obtained with the rates for admission, death, and case fatality we find that between the admission rates for the war period and the percentage of rural population there is a definite positive correlation, the coefficient being $+0.362 \pm 0.083$. This coefficient is large enough to be statistically significant and is over four times its probable error. It is not a high correlation but in view of the fact that the dividing line between rural and urban is probably too high for our purpose we are justified in drawing the conclusion that a rural population will show a higher morbidity from respiratory disease when inducted into the military service than will an urban one. A similar but smaller coefficient is found for the correlation between the rural population and the death rates. In this case the figure is $+0.311 \pm 0.087$. When the percentage of rural population is compared with the case fatality rates, however, all significant correlation disappears. The coefficient of correlation between these two series of data is $+0.16 \pm 0.09$; the low coefficient and the fact that it is not twice its probable error, deprive it of all significance. It would appear then that at least one of the factors entering into the admission and death rates is the relative urbanity of the population from which the troops are drawn, and that this variable affects the death rates through its effect on admissions and not by any demonstrable effect on case fatality.

If the relative immunity enjoyed by the city dweller when inducted into the military service be of specific character for the diseases under consideration it should follow that the rates for troops should vary inversely with those of home populations if both were exposed to great danger of infection. The death rates for influenza and pneumonia for the age group 20–29 have been calculated for the registration States of 1918. The specific rate for males of this group is not available from published figures of the Census Bureau, but it is believed that for comparative purposes the combined rate for both sexes will be equally significant. The correlation between these rates and those of natives of the corresponding States in the Army during the same period is low -0.0639 ± 0.12 and it is less than its probable error. No inverse correlation is found to exist. The inverse correlation between the Army admission rate and the civil death rates for the registration States is slightly higher, -0.2 ± 0.12, but still of such value as to be without statistical significance. That, however, infections of the character of those mentioned are more prevalent in urban communities is shown by the

correlation between the death rates for the registration States and the percentage of rural population. The figure obtained in this case is -0.44 ± 0.098. This is a coefficient comparable in significance with the positive figure obtained for natives of the various States when serving in the Army.

It may be that the actual fact will prove to be that the negative correlation between the Army and civil death rates should have shown a higher figure than that given, as two States, Vermont and Colorado, were responsible for nearly half of the plus values in the "xy" column of the computation. Both these States had death rates well above the average and in both instances this was due to an abnormally high case fatality rather than to a high morbidity. Inasmuch as the factors leading to high case fatality remain obscure it may well prove to be the case that these States are influenced strongly by some factor at present unknown which throws them out of alignment and destroys the correlation. However, there is no justification for throwing them out of consideration at present, and the only conclusion justified by these figures is that there is practically no inverse correlation between the rates of the home populations and the natives of corresponding States when serving in the Army. From this would follow that the civil population had previously developed no immunity to influenza and influenza pneumonias, in proportion to its urbanity, and that consequently such relative immunity as was shown by the relatively urban soldiers was not of a specific nature. If the civil rates for a nonepidemic period, 1913, 1914, and 1915 (same age group), are compared with the Army rates in 1918, similar results appear. The coefficient of correlation here is -0.167 ± 0.134. While the coefficient has the minus sign its size and its relation to its probable error are not such as to give it statistical significance. It seems probable, therefore, that the relative immunity enjoyed by the city dweller in the Army was the result of nonspecific rather than specific factors. This is of course borne out by the fact that the city dweller also shows a relative immunity to such diseases as epidemic meningitis which are not known to be at any time so prevalent in a population as to induce any appreciable specific immunity.

Following the suggestion in the work of Pearl,[19] who showed that there was a definite relation between the explosiveness and fatality of the influenza epidemic in cities and the total death rate and especially the rates for pulmonary tuberculosis, organic heart disease, and nephritis, the attempt has been made to correlate the Army death rate with the rate for the States in this regard. The death rates for the registration States in 1913 for tuberculosis, organic heart disease, and nephritis (age 20–29) were calculated and coefficients computed. That for the correlation between these rates and the case fatalities in the Army was $+0.179 \pm 0.11$, a coefficient without significance statistically. The same is true of the correlation between the tuberculosis, organic heart disease, and nephritis rates of the civil population and the Army admission rates. The coefficient here is -0.20 ± 0.11. This failure of correlation may be due to the fact that the element of the population whose organic weakness leads to this relation between the rates in civil life was almost entirely weeded out of the Army by the examining boards. Further the figures are not complete as the registration States of 1913 represent less than half of the States of the Union.

Certain other factors very probably entered into the production of the variations of rates between States. There may have been differences between the States in the matter of relative number of recently inducted men at the time of the fall epidemic of influenza, which was responsible for the greatest number of admissions and deaths. An attempt to determine this factor from the records fails to reveal any significant differences. Another factor, however, also difficult or impossible of demonstration, undoubtedly had its effect. This was the fact that the recently inducted men of some States were assembled at camps which showed much higher mortality during the pandemic wave of the disease than was the case for others. The comparison between the camps is brought out elsewhere. Inasmuch as the greater part of the mortality was among the recently inducted, this difference between the States is one that must have had its effect. It is probably impossible to evaluate it accurately, but it undoubtedly was one of the factors that tended to throw certain States off in the various correlations that have been recorded.

For the period of the war, then, it can not be said that the inhabitants of any one section of the country showed a marked advantage over those of any other in the matter of morbidity or mortality from influenza and pneumonia. The evidence in the figures indicates that there are two sets of causes acting separately to produce the mortality rates, one acting through the admission rates and the other through the case fatalities. One of the causes tending to increase the morbidity rate is the relative proportion of rural inhabitants in the States from which the troops come. No general cause has been discovered to account for the variations in case fatality between the States. It has proved impossible to show any correlation between the rates for tuberculosis, organic heart disease, and nephritis in the States and either the admission or case fatality rates of the corresponding troops. The fact that there was no significant negative correlation between the Army rates and civil rates for the same State during the year of the influenza epidemic is interpreted to indicate that the civil population had not acquired any specific immunity to influenza in proportion to its urbanity and that the relative immunity shown by men from more urban States was of a nonspecific character.

During the earlier months of the mobilization the relation of the nativity to morbidity from respiratory disease was much more marked. In the exhaustive study of the subject made by Vaughan and Palmer [18] it was possible to show that the total mortality and, in particular, the admission and death rates for the pneumonias were much higher in camps that drew their troops from the South Atlantic and Gulf States. They show the camps located not in their geographical position but placed in the center of the area from which they drew their troops; also that camps drawing their troops from Florida, Georgia, Alabama, Mississippi, Louisiana, and Arkansas exhibited rates much higher than the average. The camps showing the lowest rates drew their men from the Northeastern, North Central, Northwestern, and Pacific States. Of the Northern States, those sending troops to Camp Bowie and Dodge showed the highest rate. These States, Minnesota, North and South Dakota, Nebraska, and Iowa, are all shown to be above the average for mortality for the period of the war in Table 26. The Southern States, however, show no such marked agree-

ment between the figures for the war period and those of the first six months of the mobilization. The figures given by Vaughan and Palmer [18] show enormous disparities between the rates of these States and the others; however, these figures appear to be without value for comparative purposes, inasmuch as no allowances have been made for increased susceptibility of the negro troops at this time.

During this period the liability of the negro troops to contract lobar pneumonia was eight and one-half times that of the white troops.[20] In Alabama there were of military age in 1918 approximately 58 per cent of whites and 42 per cent colored.[21] If these percentages contracted pneumonia in the proportion given above, a simple calculation shows that the white, 58 per cent, furnished only 14 per cent of the pneumonia and the colored, 42 per cent, furnished 86 per cent. There are no data available on which relative nativity rates for the white troops can be calculated for the early months. The nativity tables in the Annual Report of the Surgeon General, United States Army, for the year 1918, do not separate the white and colored. However, the conclusion seems justified from the study of the camps mentioned above that the Southern States showed a much higher morbidity and mortality from the respiratory diseases during the last three months of 1917 and for the first three months of 1918 than did the other States and, further, a relatively much higher rate than the Southern States themselves showed for the whole war period. This relation of their rates will be discussed later and a tentative explanation advanced.

If the rates for the war period for groups of States are calculated the results are found to be as follows:

Group	Relative admission rate	Relative death rate	Fatality
New England	243	9.61	3.96
Middle Atlantic	217	8.26	3.60
East North Central	241	9.95	3.97
West North Central	291	12.10	4.50
Mountain and Pacific	279	9.38	3.38
East South Central and South Atlantic	257	9.44	3.66
West South Central	335	10.30	3.07

These relations are shown graphically in Chart XX, which also shows a line indicating the percentage of rural population in each group of States. This chart shows, as did the correlation, that there is some relation between the percentage of rural population and the admission rates, but none between the percentage rurality and the case fatality. Chart XXI compares the death rates for the groups of States as calculated for the war period with the rates for the same sections of the country given by Vaughan and Palmer [18] for the early months of the mobilization. It is seen that the greatly higher rates for the rural States shown in the early months did not hold for the whole war period. It must follow, then, that in the later months when the virulence of the influenza epidemic was at its height, the relative rate for the more urban States exceeded that for the rural ones.

The figures for the colored troops as regards the effect of nativity on incidence and fatality from respiratory disease are given in Table 26. States furnishing an insignificant number of colored troops are not included in this table.

The States included furnished over 99 per cent of the colored troops in the service. Owing to the well-known difficulty in obtaining accurate information for record from members of this race, it is believed that the figures are probably not as satisfactory as those for the whites. A comparison of the death rates by States for the two races, however, shows that in general the same relative

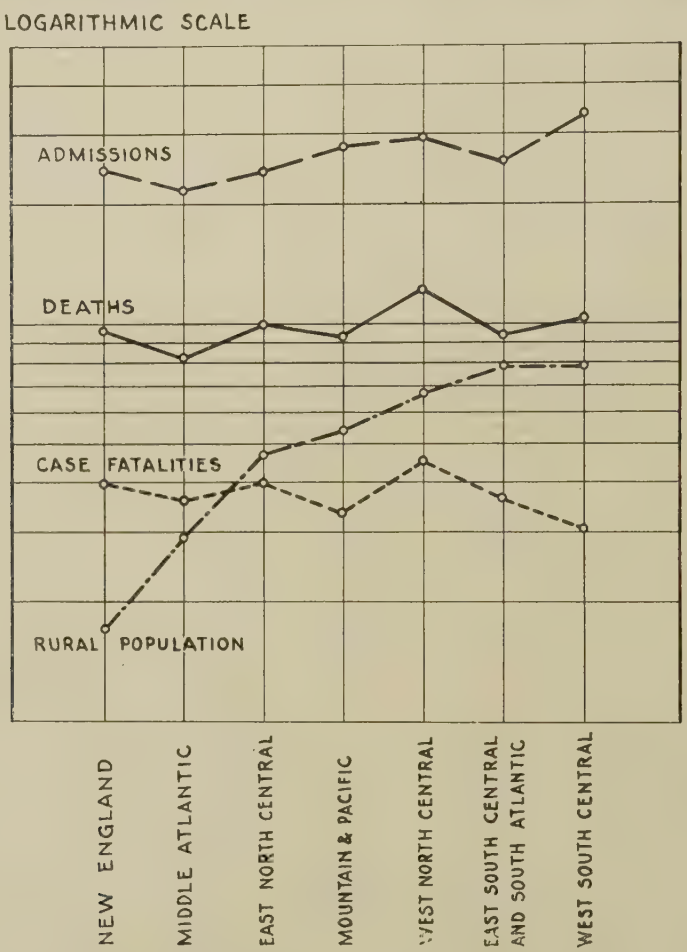


CHART XX.—Relative admission and death rates and case fatalities for the respiratory group of diseases in the various groups of States, April, 1917, to December, 1919. For facility of comparison, the different rates are drawn to a different scale. The percentage of rural population for each group is also shown

positions hold. If the correlation between the death rates by States for the two races be calculated, a coefficient of $+0.613 \pm 0.086$ is obtained. Apparently the same conditions that lead to a high mortality in the whites from a certain State when serving in the Army also tend to produce a high mortality among its colored soldiers.

TABLE 26.—*Relative admission and death rates and case fatality for the respiratory group of diseases for colored enlisted men by State of birth. April, 1917, to December, 1919. Only those States showing one thousand or more admissions are included*

State	Admissions	Relative admission rate	Deaths	Relative death rate	Fatality
Alabama	7,751	234	466	15.0	6.0
Arkansas	4,325	269	229	14.3	5.3
Florida	3,547	391	213	23.4	6.0
Georgia	11,602	267	718	16.4	6.2
Kentucky	2,250	268	114	13.1	5.07
Louisiana	8,275	328	615	24.6	7.44
Maryland	2,019	276	106	14.5	5.25
Mississippi	7,584	200	417	11.0	5.5
Missouri	1,051	242	72	16.6	6.85
North Carolina	6,121	230	328	12.0	5.36
Pennsylvania	1,017	235	39	8.7	3.84
South Carolina	10,530	279	638	18.1	6.05
Tennessee	4,467	262	307	18.0	3.87
Texas	9,299	364	338	13.3	3.64
Virginia	5,865	240	348	14.0	5.93

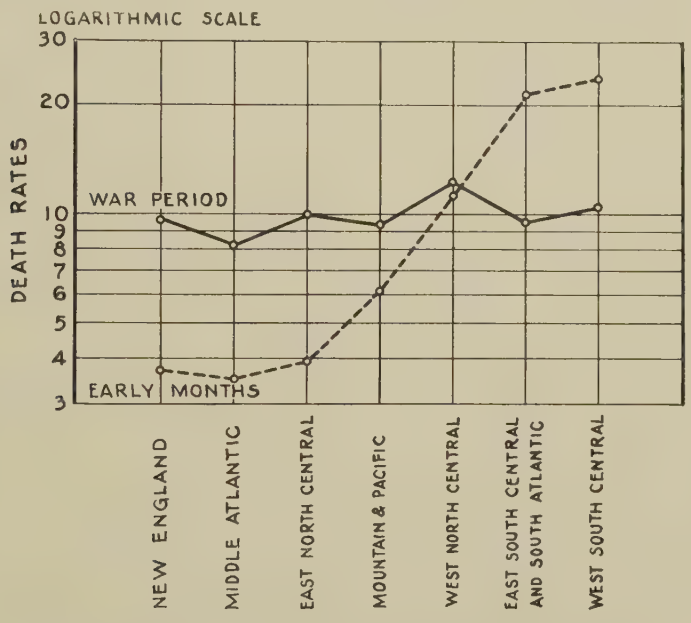


CHART XXI.—Relative death rates from the respiratory group of diseases by groups of States for the war period with the figures given by Vaughan and Palmer for the early months of the mobilization. The differences shown in the early months are largely obliterated in the longer period

CLIMATE AND WEATHER

Tables 10, 11, and 12 show that the effect of the influenza epidemic in increasing mortality was felt much less in troops stationed in tropical or subtropical climates than in the temperate regions. The effect on incidence of influenza of the warmer weather was much less than upon the death rate. Comparable groups of troops showed nearly if not quite as high an incidence

rate in tropical stations as in the United States, but the case fatality of the epidemic was far lower. The case of the white troops in Panama, with an incidence rate of 166.18 per 1,000 (higher than for the American Expeditionary Forces) and a case fatality of only 0.27 per cent, is a good example. The experience of the Porto Rican troops at Camp Las Casas is also to the point. During the October epidemic 16 per cent of its strength contracted influenza, and but 0.52 per cent died. These troops when transported to the United States showed at least as high a fatality as the whites with whom they served. The experience of the white troops in the Philippine Islands and in Hawaii was similar. In these comparisons, however, the element of length of service is difficult to eliminate, as in general the troops at these distant stations were more permanent and averaged longer service than the troops in the training camps in the United States.

The effect of climate on the incidence and mortality of troops in the United States, however, is fairly well seen. Of camps of over 5,000 strength, 16 were situated in the North and 24 in the South. The incidence of influenza as compared to the average was as follows: [22]

	Above average	Below average
16 northern camps	10	6
24 southern camps	9	15

In camps of a strength between 1,000 and 5,000 the relations were as shown below:

	Above average	Below average
24 northern camps	10	14
20 southern camps	11	9

In stations of less than 1,000 strength the following relation held:

	Above average	Below average
37 northern camps	19	18
31 southern camps	15	16

It is seen from the above tabulations that in the larger, northern camps there was a tendency to a higher incidence of influenza, but that this relation did not hold in the smaller camps. The greatly larger size of the camps of the first group thus impresses itself on the totals, and as a whole the incidence of influenza was higher for camps in the northern part of the country. There were, however, notable exceptions even among the larger camps. Camp Beauregard, La.; Camp Bowie, Tex.; and Camp Cody, N. Mex., were the three camps having the highest percentage incidence of influenza, and all three were southern camps. The same variable that interferes in so many

comparisons, and which is so difficult of evaluation, seems to apply here. What was the relative proportion of recruits in these camps? We know that as a class the larger camps contained almost all of the short-service men. The men at the smaller stations were usually selected for special service, and the personnel of these stations had passed through the larger camps. The conclusion that seems justified by the reported facts is that there is very little difference between the nothern and southern camps as far as the incidence of influenza goes. What difference there is appears to be confined to the larger camps and is perhaps due to a greater proportion of recruits in the northern camps, a factor that can not be estimated, or perhaps to the fact that the recruit was more susceptible to influenza in a northern climate.

When the mortality rates are considered, however, the advantage of the southern camps becomes evident. The corresponding figures for mortality follow:

	Above average	Below average
Large camps:[a]		
16 northern camps	13	3
24 southern camps	7	17
Medium camps:		
23 northern camps	13	10
21 southern camps	9	12
Small camps:		
38 northern camps	27	11
30 southern camps	7	23

[a] The discrepancies between the number of camps listed in the incidence and mortality tables is due to the fact that in each case only camps reporting complete figures are included. Hence the camps are not absolutely the same in the two sets of tables. The comparative value of the figures is not affected thereby.

From these figures it becomes evident that the mortality from the influenza epidemic was decidedly greater in the North than in the South. Inasmuch as the mortality has been shown to have been entirely due to the complicating pneumonias, we may say that while a soldier in a southern camp was just about as likely to contract influenza during the epidemic as his comrade in the North, his chances of complicating pneumonia and of death were very much less.

This corresponds very well with the reports from tropical stations, and it is possible to infer the generalization that while troops in warmer climates have about as much influenza during an epidemic as those in colder climates, their mortality from complicating pneumonia may be expected to be much less.

During the earlier months of the mobilization the camps that suffered most from pneumonia have been shown to have been without exception southern camps. That this was not due, however, to their location is shown by the fact that other camps, often only a few hours' travel distant, showed low pneumonia rates. The mortality in these camps, such as Camp Pike, Ark.; Camp Wheeler, Ga.; and Camp Travis, Tex., was due to the special susceptibility of their personnel; the controlling factors have been studied under the heading of influence of nativity.

The effect of weather on the epidemic is one that is difficult to estimate. Expressions of opinion by individual officers, sometimes even in the same camp, are at variance. In general it may be said that the weather at the time the great epidemic first put in its appearance in September, 1918, was fine

throughout the country. The month was somewhat cooler than the average for some years past, but even a cool September would not be expected to be cold enough to cause hardship. In some camps rainy weather prevailed during the epidemic wave; in others fair weather was reported. Of 111 stations reporting, 89 characterized the prevailing weather at the time of the outbreak as mild, 22 as severe. Of those reporting mild weather, 43 showed a mortality above the average of their respective groups, 46 below average. Of those reporting severe weather, 12 showed a mortality above average and 10 below. It is evident that weather conditions were favorable, as a rule, during the epidemic and that the mortality was little if at all influenced by severe weather when it occurred.

HOUSING CONDITIONS

It is possible to study the effect of housing conditions on the course of the epidemic from two points of view: First, the space assigned to each man in the barracks, the effect of crowding; second, the effect of the type of quarters, whether tents or barracks. It is difficult by any ordinary methods to obtain figures for either of these variables that are clean-cut and are not influenced by other factors known to complicate the situation. It is impossible to estimate with any degree of accuracy the proportion of short-service men in the different camps and as has been shown a considerable difference in this respect would introduce a factor in the comparison that would materially alter results. The same may be said of the geographical situation if comparisons are based on mortality though this is less a factor when incidence rates are compared. However, certain conclusions may be justified and, accordingly, the results of the study are given briefly.

It is evident from the study of the death rates, reported by the Census Bureau, that, in general, cities suffered from the influenza epidemic more than did the rural communities. This accords with the general experience in pneumonia mortality over a number of years. Therefore, it is to be expected that concentration of population, affording increased facilities for the transmission of the virus, would increase the incidence of the disease. Vaughan has divided the various camps existing during the epidemic into three groups—those over 5,000 men, those between 1,000 and 5,000, and those under 1,000.[23] In general it may be said that the larger the command the greater the chance for dissemination of infection and the greater the probability of crowded conditions. Chart XXII shows the result of his study in this respect. It is seen that while the size of the camp shows little effect on the incidence of influenza, the proportion of cases developing pneumonia and the number of deaths are greatly affected, the smaller camps showing a much smaller proportion of complications. A more detailed study by comparing not only the arithmetic means of the camp rates but the medians and modes as well shows that the incidence rate of influenza also was decidedly higher in the larger camps. How much of this is due to differences in physical surroundings and how much to the well recognized fact that the men in the smaller camps averaged much longer service than those in the larger, can not definitely be said.

Data as to the degree of crowding in the various large camps during the epidemic are difficult or impossible to obtain in reliable comparable form.

Figures that are obtainable seem to indicate little if any difference in incidence or mortality between those reporting crowded conditions and those showing the reverse. Such results, however, are open to the disturbing influence of the other variable factors mentioned above. It would seem that the influence of this factor is best estimated by comparisons made between different organizations in the same camp whose surroundings are substantially the same and which show practically the same proportion of recruits. A study of this character was made at Camp Humphreys, Va., during the fall epidemic.[24] The organizations reported on are divided into two groups—those in existence some time and those newly formed. The results are tabulated as follows:

Organization	Floor space per man	Sick with influenza	Organization	Floor space per man	Sick with influenza
Older organizations:	*Square feet*	*Per cent*	Newer organizations (sapper regiments:	*Square feet*	*Per cent*
7th Regiment	45	26.7	217th Regiment	55	24.5
3d Regiment	46	28.6	218th Regiment	59	20.8
5th Regiment	47	16.0	219th Regiment	68	19.3
2d Regiment	50	9.1	220th Regiment	103	13.6
Engineer Officer's Training School	70	8.8	215th Regiment	114	9.3
4th Regiment	75	7.4			
6th Regiment	78.5	2.5			

The inverse correlation between the amount of floor space per man and the percentage of infection in comparable organizations is striking. While this is the only detailed study of this kind of which record is available, suggestions of a similar relation are found in the reports from a number of camps. It is believed that such reports, dealing with otherwise comparable groups, are of more value than the massed figures from a number of camps. It seems fair to conclude, therefore, that there is to be expected a definite relation between the degree of crowding and the amount of respiratory infection.

There appears to have been little difference in influenza incidence between the tent camps and the barracks camps. If the mortality rates for all the tent camps are compared with those of all the barracks camps, there is a decided difference in mortality in favor of the former. However, as with one exception all the tent camps were situated in the South, while the barracks camps were about equally divided, it is seen that the climatic difference elsewhere discussed interferes with the comparison. If all the northern camps be excluded from comparison it is seen that there is little or no difference in mortality for the two groups. Camps with relatively high and relatively low mortality are found in both classifications.

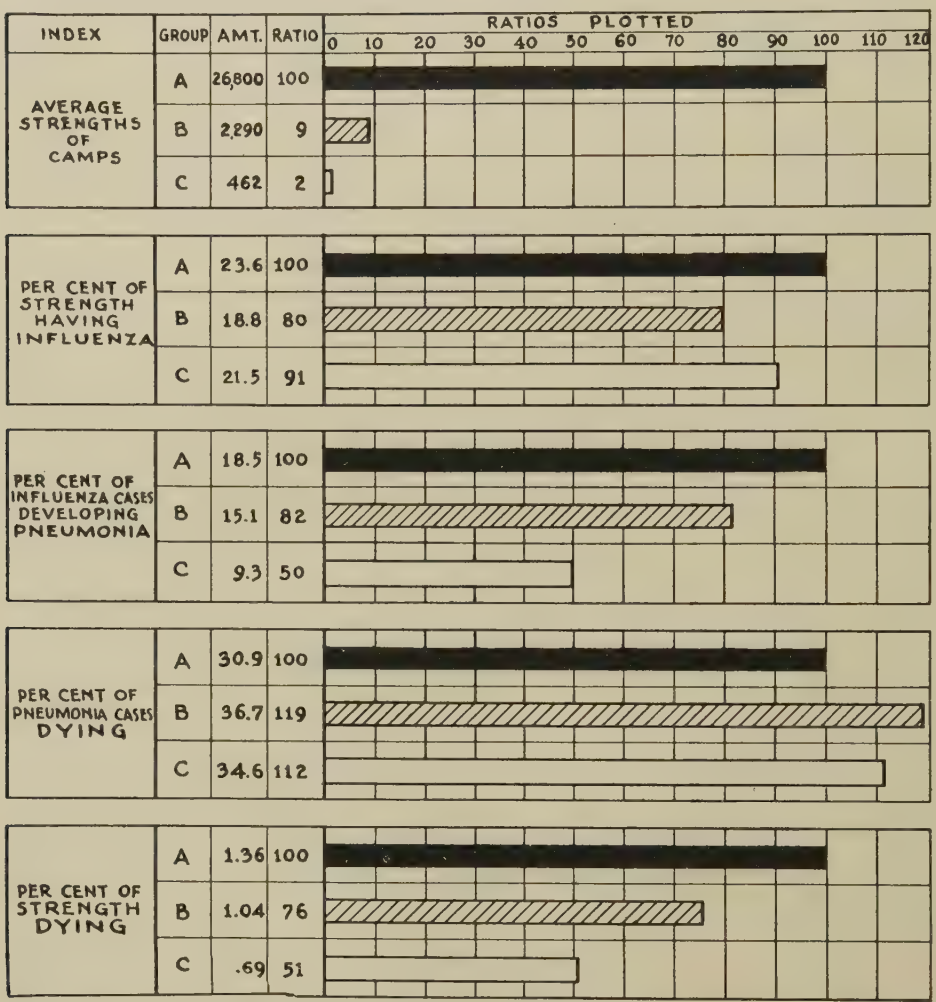
MODE OF TRANSMISSION

The actual mechanics of the mode of transmission of the virus of influenza is a point over which argument has taken place. There is to-day substantial agreement that the disease is transmitted from individual to individual, rather than by aerial convection, although the latter hypothesis has found many proponents in the past. The known facts of the matter may all be explained without recourse to the theory of spread by the air.

The generally accepted idea of the method of spread of this and similar diseases has been expressed in the general term applied to them, that of

"sputum-borne diseases." Most of the preventive work directed against influenza and the pneumonias has been based on this idea of the principal method of spread. The obvious fact that infective material is constantly sprayed into the air by the coughing patient, from which it is equally readily inhaled by those near by, has tended to render us oblivious of other possibilities

COMPARISON OF EFFECTS OF THE FALL EPIDEMIC OF INFLUENZA ON CAMPS OF DIFFERENT SIZE IN THE UNITED STATES



EXPLANATION: GROUP A OVER 5000 MEN, GROUP B 1000-5000 MEN, GROUP C LESS THAN 1000 MEN

CHART XXII

perhaps as important. The rôle of the hand in the spread of these diseases has been emphasized, particularly by Lynch and Cumming,[25] and the importance of "hand-to-mouth" routes in disseminating infection has received much study. It can not be said that any agreement has been arrived at as to which method is of the greater importance in spreading disease. It is entirely probable that both methods play their part in the process.

That the number of new cases depends to a great extent on the closeness of contact between infected and noninfected individuals is shown in a number of ways. Though figures as to the crowding of camps during the epidemic are inconclusive, special studies made of the relation between floor space and influenza incidence in different units of the same camp, as shown above, indicate that there is a definite relation between crowding and the spread of the respiratory disease. The influence of varying degrees of closeness of contact is shown by figures reported from Camp Custer, Mich., during the fall epidemic (1918).[26]

Influence of contact on incidence and mortality, Camp Custer, September–October, 1918

	Percentage contracting influenza	Percentage contracting pneumonia	Deaths
Total camp	23.4	5.4	1.7
Medical and dental officers	25.6	5.5	1.2
Other officers	6.6	1.4	0.0
Ward men in base hospital	11.7	2.5	0.8
Other Medical Department men in hospital	12.5	2.6	1.5
Army nurses	30.6	10.4	1.4
Civilian nurses	36.4	6.6	0.8

This tabulation shows plainly the increased incidence in groups coming in closest contact with infected individuals.

Vaughan (Warren) showed a similar relation among civilians in Boston.[27] His figures showed that "sleeping contact" was over twice as apt to result in infection as the less intimate forms of contact in the family. These figures seem to have some significance in the question of the relative importance of the hand and droplet in transmission. Apparently the latter method is more concerned in sleeping contact than the former. Lynch and Cumming [25] maintained that the indirect transmission of infection from hand to hand by means of infected dishwater in the dipping method of washing mess kits was the major route of transmission. The figures presented in their report taken from organizations of the port of embarkation, Newport News, Va., support their contention satisfactorily. They have also shown by experimental methods that the route they suggest is a feasible one. Their conclusions have been criticized, however, on the ground that other factors known to be concerned in the incidence of the disease, such as length of service, crowding, etc., were not eliminated in making their comparisons. Other officers have failed to show a similar relation between their organizations.[28] At Camp Jackson, S. C., a group of organizations, carefully using boiling water in the washing of mess kits but composed of men of short service, showed a very much higher incidence rate during the fall outbreak than did another organization of much longer service that took no special care to effect thorough sterilization of dishes. Both used the dipping method.[29] Here apparently the element of length of service was far more important in determining morbidity than was the sterilization of the mess kits.

Special bacteriologic experiments conducted at Camp Meade, Md., showed that, even when relatively cool, the soap in the dishwater was sufficient to kill the usual organisms found in respiratory infections, such as the pneumococci

and streptococci.[30] These experiments, however, did show the possibility of the transference of organisms of the colon group by this means. As far as the influenza virus is concerned, the results are entirely inconclusive, as the exciting agent of this disease is not yet definitely recognized.

The consensus of opinion, based on the experience of the epidemic, would seem to be that while the rôle of the hand in the direct and indirect transmission of respiratory disease should receive careful study and fullest consideration, the claim that this represents the major avenue of spread of these diseases can hardly be regarded as proved, and attention to this possible means of travel of the virus should not be allowed to draw attention from methods of prevention based on the more usually accepted theories of the method of transmission.

In spite of all evidence pointing to the importance of contact, attempts to transmit the disease experimentally under controlled conditions have uniformly failed. The United States Public Health Service sponsored two experiments of this character during the fall outbreak in 1918.[31] One experiment was carried on in Boston, with 100 volunteers from the Navy, of the most susceptible age. None were known to have had influenza previously. These men were treated with influenza bacilli, with nasopharyngeal secretions, with and without filtration, by intranasal sprays, and by direct swabbing from patient to volunteer. The attempt was made to induce the disease by the injection of citrated blood from patients and the injection of filtrates of nasopharyngeal secretions. Finally these men were exposed to the most intimate personal contact with patients in wards, all with the complete failure to produce the disease. A similar experiment was conducted with the same result in San Francisco. The explanation of this result is lacking. Either the proper method of transmitting the disease was not used, which seems very unlikely in view of the diversity of methods employed, or the volunteers themselves were immune to the disease either naturally or through previous infection in spite of their negative history. This latter hypothesis is hardly satisfactory though seemingly more probable than the former.

It can only be said then that the experience of the war has confirmed our previous belief that influenza is carried by infected persons and not for any distance through the air. The exact means by which the virus is transmitted from person to person, as well as the usual portal of entry in each case, remains unknown. While other means of transmission can not be excluded, and doubtless play their part, the known facts are not inconsistent with the generally accepted idea that the secretions of the respiratory tract expelled into the air by the act of coughing and inhaled by susceptible persons in the immediate neighborhood constitute the most important route.

As to the duration of the period of infectivity of the individual case, no reliable deductions may be made. The negative attempts at transmission experiments already quoted suggest the possibility that the infective period is very short, possibly even limited to the period of incubation or invasion. This idea is also supported by the observation that different methods adopted by different commands in the handling of their influenza cases apparently produced little effect on the incidence of the disease. Some camps attempted

the immediate hospitalization and isolation of all suspicious cases, others reserved their hospitals for the seriously ill only, leaving the lighter cases for treatment in regimental infirmaries or in quarters where opportunities for transmission to the uninfected would appear to be much more numerous. It is not possible to show that this latter method of handling the situation resulted in any increase in the relative number of cases. The possible explanation may lie in a very brief period of infectivity, limited to the period of invasion or the earliest hours of the demonstrable presence of the active disease.

PREVENTION

With the preceding studies in mind, it appears evident that the prevention of the fatal pneumonias that attack armies may be approached from two points of view. First, the classical one that pneumonia is a primary disease directly due to the dissemination of the various organisms to which pulmonary inflammations may be attributed, aided by such well-recognized predisposing causes as chilling and exhaustion. Second, the point of view developed in the preceding pages which seems to show that during the period of an influenza cycle at least the great majority of pneumonia cases bear a direct relation to the prevalence of the so-called common respiratory diseases which during such a period appear to be definitely influenzal in origin. The second point of view is evidently the one applicable to the period of the World War. The figures cited and the relations shown make the conclusion inevitable that had it been possible to exclude the action of the influenza virus from the Army, the pneumonia mortality would have been so far less than it actually was as to have been of very little importance in the death records of the war. This statement holds for the months preceding and following the great fall outbreak as well as for that period.

While it may be shown that certain measures tend to diminish the proportion of influenza cases complicated by pneumonia, the prevention, or limitation, of the number of such cases remains the fundamental problem in the prevention of such pneumonia as was seen during the war period. This problem has not been solved. Before proceeding to a short résumé of the various means by which the prevention of influenza was attempted during the war, and the attempt to assign to them their relative value, it may be admitted that as far as the experience of the last pandemic goes, no practicable preventive measures have shown themselves to be of decisive value. Such measures as have shown some value appear to serve the purpose mainly of delaying the spread of the infection, of lessening the explosiveness of the outbreak. In a military camp this is an accomplishment of no small value inasmuch as it serves to reduce greatly the daily number of admissions during an outbreak, and correspondingly to lessen the strain on hospital facilities and personnel, with the result of giving to the individual patient the possibility of better care and increased chance of recovery. Preventive measures accordingly should be judged by the measure of their ability to prolong an outbreak by the diminution of its explosiveness, as well as by their ability to lessen the percentage of persons attacked.

MEASURES DESIGNED TO PREVENT THE ENTRANCE AND SPREAD OF INFECTION IN A COMMAND

Quarantine

Absolute quarantine has been shown definitely to exclude influenza. The experience of Fort St. Philip, on the Mississippi River below New Orleans, is a case in point. This post was able to maintain an effective isolation and entirely escaped infection during the fall wave of the disease.[32] The San Francisco naval training station, situated on an island, carried 4,950 men through the height of the epidemic without a case.[33] However, very few stations are so situated as to be able to maintain perfect isolation, certainly none of the size of the great war training camps. Certain camp commanders, recognizing the futility of attempting quarantine in the face of the necessary supply problem, troop movements, etc., made no attempt to enforce isolation. Others restricted intercourse between their commands and adjacent communities in so far as it was possible to do so. There does not appear to be any significant difference between the two groups of camps thus divided. Vaughan's studies showed the following relations in this respect.[22]

	Influenza incidence			Influenza incidence	
	Above average	Below average		Above average	Below average
Large camps:			Small camps:		
34 quarantined	17	17	38 quarantined	19	19
6 not quarantined	3	3	8 not quarantined	3	5
Medium camps:			Total:		
27 quarantined	10	17	99 quarantined	46	53
7 not quarantined	4	3	21 not quarantined	10	11

It is seen that the totals show that 53 of 99 quarantined camps showed an incidence below the average, while 11 of 21 unquarantined camps were also below average in this respect. The respective percentages were 53.5 and 52.4. There is here no significant difference leading us to believe that such quarantine regulations as proved practicable during the war are of any value in reducing the total incidence of disease. In the six large camps that did not attempt to enforce quarantine, the duration of the epidemic was as follows: Camp Sheridan, Ala., 3 weeks; Camp Jackson, S. C., and Camp Taylor, Ky., each 4 weeks; Camp Forrest, Ga., 5 weeks; Camp Humphries, Va., 6 weeks, and Camp Logan, Tex., 7 weeks, an average of 4.8 weeks as compared with 4.9 weeks for the 36 large camps for which information is available.[34] There is no evidence here that quarantine availed to prolong the outbreak and thus distribute the cases over a longer period. To be of avail in excluding influenza, quarantine must more nearly approach perfection than proved practicable in the large camps of the war period. The experience of certain civilian institutions too, from which the disease was excluded by quarantine until the subsidence of the outbreak, only to have it appear promptly as soon as restrictions were removed, seems to indicate the futility of general quarantine as a military measure. That certain camps, where great stress was laid upon quarantine, had little influenza is true. The experience of Camp Wheeler, Ga., has been quoted in

support of this measure.[22] The Camp Wheeler report states that quarantine was effective in limiting the disease almost entirely to recruits who brought it with them. The personnel of Camp Wheeler, other than the new men, was very small and was composed almost entirely of men who had passed through the relatively severe spring outbreak in that camp, when indeed the influenza rates were higher than they were in the fall. The fact that these men were all of long service and had passed through one well defined outbreak less than six months before is a more probable explanation of their immunity than the institution of quarantine. On the other hand, Camp Humphries, Va., which instituted no quarantine, had a lower incidence of the disease than did Camp Wheeler.

The prohibition of mingling of commands within the camp has received rather general indorsement. Its value appears to lie in the reduction of the explosiveness of the outbreak. The following extract from a report from Camp Lee, Va., illustrates this point:[35]

> It is very doubtful whether any measures taken reduced the incidence of the disease. The quarantine seemed to have no ultimate effect, but did delay the appearance of the disease in the organizations so isolated. For instance, the veterinary training school of about 3,800 men established a most rigorous quarantine and all members of the command had their noses and throats sprayed daily with argyrol, consequently they had very few cases, until October 5, when the epidemic reached a sudden peak and then rapidly declined, they being practically free from the disease in one week thereafter. Therefore, it would seem that the only benefit from the measures taken was that this camp was not overwhelmed at any one time by the number of sick. The disease was spread over five or six weeks, allowing better care of the sick.

It would appear, therefore, that experience during the World War indicated that while quarantine regulations are powerless to protect a large command from infection during epidemic outbreaks of influenza, the restriction of intercourse between the different organizations of a command may be of great value in prolonging the outbreak, thus permitting better care of the sick.

Of the 34 large camps that instituted quarantine, 23 conducted a special medical examination of all new men entering camp with a view to the detection of infected individuals and their prompt separation from the uninfected; 19 of the latter also placed the new men in a detention camp, and 8, in addition to the above measures, gave all men joining a prophylactic spray.[34] These 8 camps showed an influenza incidence, during the epidemic, of 22 per cent as compared to the 23 per cent average incidence of the large camps as a whole. It is not evident that these measures availed materially in preventing the entrance of infection. Although no figures are available to support the contention, it would appear that physical examination of new arrivals in a camp should tend to diminish the explosiveness of an outbreak, as the principles are similar to those that govern in the matter of interorganization quarantine. The objection found to measures of this character, however, was the practical one that in times of epidemic the number of officers available for duties of this character is very small, and the rush of work such as, almost inevitably, to result in hasty, more or less perfunctory examination. Such examinations are of little value and take medical officers away from other, possibly more important duties.

Medical Inspection

Medical inspection, carefully performed, is of unquestioned value in securing early treatment of the sick. It is well known that during an epidemic men are often slow to report for treatment and frequently persist in going about their duties for hours or days when actually ill. The better the morale of the troops, especially in the face of the enemy, the greater the danger of this taking place. It is mentioned in reports from the American Expeditionary Forces that men kept their places in the ranks until forced to fall out, often with fully developed pneumonia. Daily, or twice daily, medical inspection of the men, taking temperatures in suspicious cases, serves to detect such cases early and to reduce the likelihood of serious complications. There is, however, nothing to show that the institution of this measure materially reduced the incidence of influenza in the camps employing it. Under practical conditions the difficulty of devoting to this measure the time necessary to render it effective makes its satisfactory application almost impossible. Of the 78 camps employing daily inspection of the troops, half were above the average in incidence and half below. The same results were obtained in the 30 camps that did not institute it.[22]

Use of the Mask

The value of face masks worn by the whole of a command has been the subject of much argument. In the first place, if we hold with those who maintain that the main route of infection is "hand to mouth" most of the theoretical value appears to disappear, though it may limit to some extent the number of times the hand visits the mouth. It appears to be generally conceded that the use of the mask by attendants on the sick, exposed constantly to infection, is of value. That the use of the mask was universal among hospital attendants is a fact. It is equally true, as shown by the Camp Custer figures given above, that such attendants, especially nurses, were attacked in a much higher percentage than the average. They were of course constantly exposed and were undergoing severe strain in the performance of their duties. Under these circumstances judgment as to the value of the mask becomes difficult. Reports from the Durand Hospital in Chicago indicated great value in protecting attendants and in preventing cross infection among patients.[36]

It appears that masks, to be effective, should be of a certain definite thickness of material and that there are differences in the value of different materials used for their construction. Reports from Camp Grant, Ill., in the earlier months of the mobilization, while confirming the impression that cross infection may be limited by this means, have shown that a certain critical thickness of gauze must be used to prevent the passage of bacteria.[37] Too great a thickness was found to result in an uncomfortable mask that in many instances did not allow the free passage of the breath, necessitating the passage of the latter around the mask rather than through it. The experiments showed that if the number of threads in the warp of the gauze be added to the number in the woof and the sum multiplied by the number of thicknesses used, the resulting figure, to insure efficacy, should be at least 300. Experiments carried on by medical officers at the Rockefeller Institute for Medical Research indicated

that gauze was a relatively inefficient material for the construction of masks.[38] They recommended the use of a three-layer mask of butter cloth. The Camp Grant experiments showed that if a mask be temporarily removed, allowed to dry, and then resumed in the reverse position it becomes a disseminator of bacteria rather than a filter. It was therefore recommended that each mask be marked in such a way as to indicate the side to be placed next the face. When worn for their protection by the uninfected the nose should be covered as carefully as the mouth.

Further experiments performed at the instance of the National Research Council tested various mask materials against a dry suspension of *B. prodigiosus* in air, the suspension being passed through a filter and the bacteria recovered in absorption bottles containing saline.[39] The latter was then plated out and the count after incubation compared with that of the same suspension run without filtration as a parallel control. These experiments showed that the three-layer butter-cloth mask, shown by the experiments at the Rockefeller Hospital to be efficient in preventing the projection of infected droplets by the person wearing it, is by no means satisfactory in protecting the wearer from the inhalation of bacteria suspended in the air after the bacteria have lost their original coating of moisture. In different experiments from 44 to 76 per cent of the bacteria passed this mask when used dry. It was found that its efficiency was greatly increased by moistening, and they suggest the use of a mask based on this principle. This work suggests that the care used by many to avoid the use of a mask dampened by the breath or by perspiration was misapplied. These workers also tested certain grades of felt which they found to restrain the passage of bacteria perfectly. Masks of this material would have to be made over a frame to obtain sufficient filtering surface. There is no report of the actual use of masks of this design.

It is evident that the mask may be an efficient means of limiting the spread of infection. It is equally evident that unless the necessary conditions are fulfilled in the construction and wearing of the mask it may be useless and in some cases even harmful. For this reason statistics as to the results attained in the general use of the mask in the Army camps during the epidemic are of doubtful value. The classification of the camps in this respect follows:[22]

	Percentage incidence of influenza			Percentage incidence of influenza	
	Above average	Below average		Above average	Below average
Large camps:			Small camps:		
19 using masks	9	10	16 using masks	11	5
15 not using masks	7	8	25 not using masks	13	12
Medium camps:			Total:		
6 using masks	1	5	41 using masks	21	20
37 not using masks	20	17	77 not using masks	40	37

The mass statistical evidence shows no benefit in general masking. However, the considerations given above lead to caution in accepting this negative evidence. The expressions of opinions by medical officers are decidedly conflicting It is apparent in the consideration of this matter, as in so many others, that the

preponderant influence on camp rates of the relative proportions of recruits and longer service men, and, especially when comparing mortality, of geographical position, determines the camp rates and that other factors have had relatively little effect. No one has expressed the opinion that the mask properly used can do harm. Experimental evidence points to the probability of its usefulness. Practical experience shows that the necessary conditions for its proper use are rarely attained except when used by trained hospital attendants for their own protection. The conclusion is that the mask is probably of great value potentially but that the difficulties in securing its proper use by the mass of a command are such as to render its general employment of doubtful utility.

Use of Prophylactic Sprays

The use of prophylactic sprays or gargles, not only by newcomers but as a general measure throughout the camp, was practiced in many commands. The antiseptics used varied greatly. Perhaps the most generally used were dichloramine-T, quinine solutions, and silver nucleinate or argyrol. The value of the measure and the relative value, if any, of the different solutions recommended have not been determined by controlled observations. When the spray was used in a camp, lightly affected by the epidemic, local opinion was favorable; when it failed to prevent a high incidence it was condemned as ineffective. There is no general evidence that prophylactic treatment reduced the incidence of disease in the commands employing it. The figures for the camps follow:[22]

	Percentage incidence of influenza			Percentage incidence of influenza	
	Above average	Below average		Above average	Below average
Large camps:			Small camps:		
12 using prophylaxis	7	5	21 using prophylaxis	13	8
25 not using it	12	13	24 not using it	11	13
Medium camps:			Totals:		
13 using prophylaxis	7	6	46 using prophylaxis	27	19
17 not using it	8	9	66 not using it	31	35

These figures appear to indicate an increased incidence in camps using prophylactic methods. While, as indicated above, other factors may have been responsible for the difference shown in the two groups, the result is suggestive of possible danger in the use of general spraying. When used on large numbers of men the danger of conveying infection from throat to throat would appear to be very real, especially as the necessities of the case during an epidemic require that this work be delegated to hastily trained personnel. From Camp Funston, Kans.,[34] it was reported that spraying of the nose and throat with antiseptics as a prophylactic for contacts and attendants predisposed to infection rather than protected. This was proved by a group experiment of 25 attendants on influenza cases who were not sprayed. One contracted the disease. Of 25 sprayed with protargol solution 17 contracted the disease. All 50 attendants wore masks and worked under the same conditions in the same temporary hospital.

At Camp Cody, N. Mex., daily spraying was employed in many organizations but not in all.[22] Its use was discontinued upon discovering the incidence of disease to be much greater in organizations in which its use was carefully employed than in others in which it was not used.

At Camp Upton, N. Y., a control experiment was carried out with two battalions of the depot brigade; 800 men were treated daily by spraying the nose and throat with a solution of dichloramine-T.[34] A like number were held untreated as controls. Over a period of 20 days the incidence in the two groups was the same.

The experience of the epidemic thus shows that not only is there no evidence of benefit to be derived from the general use of the prophylactic spray but there is definite evidence from certain quarters that its use may at times distinctly increase the incidence of disease.

Protection of Troops from Undue Fatigue

The effect of fatiguing drills and other duties, especially on newly joined recruits, has been the subject of considerable study. When a number of drafted men arrived at a training camp the necessary processes of enrollment and equipment, of physical examination, of vaccination against smallpox, and of inoculation against the typhoid fevers involved a period of several hours during which the men were constantly standing in line, much of the time with little or no clothing on. This strain after a long journey by troop train, often ending at camp during the night, and followed by the reaction from the inoculations has been held by some to be responsible for the high incidence of disease among recruits. Much of the fatigue and strain thus imposed upon the recruit is possibly a military necessity, although this is a debatable question.

During the summer of 1918 repeated waves of influenza and pneumonia occurred at Camp Funston, Kans., each wave in turn practically confined to recently inducted troops. In one such outbreak a study of the effect of variation in the training schedule was made.[40] Recruits were quartered in two separate parts of the camp, for convenience called A and B herein. Owing to local conditions the amount of drill and fatigue duty in camp A was not over half that in camp B. Owing to congestion at the receiving station the troops at camp A were held from two to four days before undergoing the ordeal of physical examination, inoculation, and equipment. During the first two weeks of camp life this contingent had 3.7 per cent of its strength reported sick, while the men at camp B on the fuller schedule reported 6.5 per cent during the same period. The author of the report suggested that "the whole period of inoculation be regarded as one in which the body is being called upon for a severe biological effort," that consequently all other effort should be reduced to a minimum, and that recruits should not be expected to reach a point where hard work on full time is possible for at least a month.[40]

That the great difference in incidence among recruits as compared to seasoned troops is not the result of the inoculations against typhoid and paratyphoid is the conclusion drawn from a study of this point made at Camp Funston coincidentally with the work above mentioned.[41] It was shown that the curve of pneumonia incidence was a fairly regular one of the usual fre-

quency type, with its highest point near the end of the second week in camp. There was no detectable relation between this curve and the dates of the typhoid vaccinations and no grouping of extra cases on or following the inoculation dates. This agrees with the result of a series of experiments on mice carried on at the Army Medical School which showed that animals inoculated with typhoid vaccine were less susceptible to streptococcus infection than were control animals.[42] The pneumonia commission at Camp Wheeler, Ga., in the fall epidemic (1918) were unable to trace any relation between pneumonia incidence and inoculation dates.[43]

The conclusion is that the association of disease with the inoculations is merely coincidental and that if the latter in any way increases susceptibility to respiratory infection it has proven impossible to demonstrate it by statistical methods.

That the Camp Funston figures, showing the effect of fatigue on disease incidence, are probably of general value is indicated by the numerous reports of high sick rates in newly inducted troops during the fall epidemic. Some of these have been noted above in the consideration of the effect of length of service. The effect of fatigue and exposure on seasoned troops is seen in the high proportion of pneumonias and the high case fatality of the American Expeditionary Forces.[1] It seems well established, then, that during the prevalence of respiratory disease in a command, training schedules, especially those for the newer men, should be reduced to the minimum permitted by military necessity. Indeed it would seem that military objectives would in the long run be furthered by this course.

Limitation of Public Gatherings

Almost all the large camps prohibited the gathering of large numbers of men indoors at entertainments and the like.[44] Such a ruling would naturally follow the adoption of interorganization quarantine, which appears to be of distinct value in slowing the spread of an epidemic. An interesting instance of increased incidence of influenza following such gatherings was recorded at the San Quentin Penitentiary in California,[45] where the weekly moving-picture show was shown to be followed regularly by an increase in the number of new cases of the disease. That gatherings indoors may also be the cause of dissemination of the virus is suggested by the fact that on the substitution of outdoor band concerts for the indoor show at this institution the number of cases two days later was still significantly larger than during the rest of the week. This suggests that the massing of men in close-order drill may have elements of danger. However, men associated in drill are usually together in mess and barracks, and the drill can hardly be expected to exert much extra influence.

Use of the Cubicle

The consideration of the advantages of separating men's beds by means of hanging sheets or halves of shelter tents does not differ whether the system be used in hospital wards for the limitation of secondary infections or in the sleeping quarters of the men to prevent or limit the dissemination of bacteria during sleeping hours. Facts tending to show the value of the system in the hospital

are equally applicable to its use in barracks. There is no evidence in the mass statistics that the lack of the use of the cubicles in the few hospitals that failed to utilize this precaution was of any influence on their mortality rates. Nor is there any statisical evidence that screening between beds in barracks lowered the rate of incidence. Indeed, of 19 large camps using the cubicle in barracks, 12 showed an incidence rate above the average to 7 below it; of 19 not using the screen, 7 were above the average and 12 below.[22] However, if the average percentage incidence of the two groups is calculated it is found that the two figures are practically the same.

The studies of the special commission at Camp Pike, Ark., during the fall epidemic of 1918, furnished definite evidence as to the value of the cubicle in preventing cross infection in hospital wards.[13] Similar reports were made earlier from Camp Dodge, Iowa,[46] and Camp Taylor, Ky.[47] A report from Camp Hospital No. 1 at Camp Upton, N. Y., gives additional evidence.[22] Due to lack of material certain beds in this hospital were not separated by sheets. The percentage of pneumonia cases among occupants of these beds was 23.36, while among those in cubicles the pneumonia incidence was 19.3 per cent. Such studies as these appear to indicate that the degree of isolation procured by the installation of the cubicle system is sufficient to have some effect on the distribution of bacteria.

Certain other measures having the same general object were adopted here and there. In some places sheets were hung down the centers of mess tables, or men were allowed to sit on one side only. Seats at mess were separated by a wider space than usual. The regulations as to the distance between beds and requiring the men to sleep head to foot were more strictly enforced. There is little evidence of any practical results from these measures during the severe epidemic.

In summary, of the measures instituted to prevent the entrance of influenzal infection into a camp and to limit its spread once it has obtained a foothold, it has been shown that strict quarantine may prevent the disease entirely. This is rarely practicable in large commands, and the most that can usually be expected is to delay the outbreak somewhat. Interorganization quarantine within the camp and the prohibition of unnecessary gatherings undoubtedly serve to diminish the explosiveness of an outbreak and to enable the individual cases to be better cared for. Medical inspection of commands daily or oftener, with prompt removal of discovered cases, should serve the same purpose. The use of the mask by the command in general, while theoretically sound, is beset with so many practical difficulties in application that until properly constructed masks can be supplied in quantity and their use in an efficient manner enforced, decisive results from their use can not be expected. Masking of hospital attendants and of patients has been shown to be of great value. The mask is more effective when moist than when dry. The use of prophylactic sprays has been shown to be not only useless but dangerous. Troops should be spared all unnecessary fatigue and exposure during an epidemic. The avoidance of crowding in barracks is undoubtedly of great importance, and the use of the cubicle in sleeping quarters as well as in hospital wards may be regarded as of proven value. When all is said, however, the best result to be expected from any or all

of these measures is a slowing of the progress of an epidemic rather than any considerable diminution in the number of cases. The differences in admission rates of different commands depend primarily on differences in the relative numbers of susceptibles, mainly recruits. This being the case, the development of means of individual prophylaxis or immunization becomes of prime importance.

Prophylactic Vaccination

With the coming of the severe fall wave of the influenza epidemic, attention was very generally directed to the possibility of individual protection by means of inoculation of bacterial vaccines. Though reports had indicated great uncertainty on the part of the bacteriologists as to the primary etiological relationship of the Pfeiffer bacillus to the disease, most vaccines used contained this organism. It was usually combined in varying proportions with type pneumococci, hemolytic streptococci, and even staphylococci. Many apparently favorable reports were made, but owing to the explosive character of the epidemic and its appearance nearly simultaneously in all parts of the country, most extensive vaccination experiments were made after the epidemic was on the wane or at least well under way. If, then, it be remembered that the case fatality is greatest during the earlier part of an outbreak, and if the results in persons vaccinated relatively late in an outbreak are compared with a control group whose cases and deaths were counted from the beginning, it is seen that it is easy to obtain figures more favorable to the vaccine than the facts warrant. Many such reports were published. The results of vaccination with any of the organisms used during the war period in reducing the incidence of the primary influenzal infection may be regarded as negative.

With the development of knowledge of the specific differences in the types of pneumococci, hopes were aroused that vaccination with the types responsible for the greater number of cases might reduce the incidence of pneumonia. The first large-scale experiment in this country was undertaken at Camp Upton, N. Y., in the spring of 1918.[48] Over 12,000 men were inoculated with a saline vaccine containing pneumococci, types I, II, and III. In the 10 weeks subsequent to this treatment the vaccinated men remained free from pneumonia due to these types, while the 19,000 unvaccinated men furnished 18 such cases. There was also shown a marked reduction in the rates of the vaccinated troops for Group IV pneumonias and especially for streptococcus pneumonias. The total pneumonia incidence was 1.33 per thousand for the vaccinated for the 10-week period, and 5.29 per thousand for the control group. It proved impossible to compare the groups further, owing to their departure for France. The vaccine used in this experiment contained equal parts of each of the three fixed types of pneumococci, 1,000,000,000 of each for the first dose, 2,000,000,000 for the second, while the third and fourth doses contained 3,000,000,000 each of Types I and II and 1,500,000,000 of Type III. The injections were made at weekly intervals, the majority of the men receiving 3 or 4 doses, some only 1 or 2.

A similar experiment was carried on at Camp Wheeler, Ga., in the fall of 1918.[49] In this instance the vaccine was a lipovaccine containing 10,000,000,000 cocci of each of the three fixed types, 30,000,000,000 in all. It was

prepared at the Army Medical School. It was given in one dose of 1 c. c The reactions, general and local, were not unduly severe and no serious disability resulted therefrom. The troops vaccinated included both white and colored, both seasoned men and recruits. The period of observation following the inoculation included the period of the fall epidemic of influenza. The results are tabulated below. The vaccination of the older men had been accomplished prior to the arrival of the recruits. The latter were inoculated immediately on arrival in camp.

Recruits (less than one month's service):	Per thousand
White—	
Vaccinated	38. 6
Unvaccinated	64. 0
Colored—	
Vaccinated	125. 0
Unvaccinated	413. 0
Total recruits—	
Vaccinated	58. 2
Unvaccinated	115. 2

Seasoned men:	Per thousand
White—	
Vaccinated	5. 2
Unvaccinated	40. 0
Colored—	
Vaccinated	14. 8
Unvaccinated	78. 4
Total seasoned men—	
Vaccinated	7. 2
Unvaccinated	46. 4

The same pneumococcus lipovaccine prepared at the Army Medical School was tried to a considerable extent on volunteers in other camps following the promulgation by the Surgeon General of a circular letter, dated October 25, 1918, authorizing its general use. It was not used, however, until a time when the accurate estimation of results was interfered with by the shifting of troops incidental to the demobilization. Favorable reports were received from the vaccination of large numbers of men at Camps Funston, Kans.; Dodge, Iowa; Dix, N. J.; Sherman, Ohio; Wadsworth, S. C.; and Devens, Mass.[22] In Camp Devens, it was estimated that the pneumonia rate in vaccinated men was about one-fourth that of the unvaccinated. Camp Custer, Mich., reported unfavorable results on a small group. On the whole the reports received from camps in this country were decidedly favorable. In the American Expeditionary Forces, a carefully controlled experiment was made at Camp Lusitania.[50] Here, 5,000 men were vaccinated and 3,861 held as controls. Several varieties of vaccine were used, a lipovaccine containing pneumococci types I and II, and one containing all three types, both having been prepared at the Army Medical School, and a saline vaccine prepared by the Pastuer Institute, Paris, containing "pneumococci, streptococci, staphylococci and *B. influenzæ*." There was little respiratory disease in the command during the period of observation January to June, 1919. The results, however, indicated that the lipovaccines reduced the incidence of pneumonia to about one-fourth that of the controls. The saline vaccine showed no such result. All vaccines showed a reduction in the incidence of influenza and common respiratory diseases, the saline vaccine in this instance showing as good a result as the others. A careful series of serological observations was made on representative numbers of the vaccinated men. Blood was taken from these men semimonthly for the period of observation. Antibodies were demonstrated for pneumococci types I, II, and III, beginning the second week after inoculation, reaching a high point at the end of four weeks, then gradually decreasing during the balance of the period. The response to type I was most marked, type II next, and

type III least. The sera were tested by agglutination and by complement fixation methods. The men inoculated with the saline mixed vaccine gave substantially the same reactions as those on whom the Army Medical School lipovaccine was used. Protection experiments with mice also demonstrated the value of the treatment.

SUSCEPTIBILITY AND IMMUNITY

During a great pandemic outbreak of influenza the disease is so widespread and affects so large a proportion of the population at one time as to lead very naturally to the impression that practically 100 per cent of the population has been exposed to the disease. If this be so, we must assume that certain individuals, perhaps the majority, possess immunity against this infection, as the figures do not indicate that the entire population becomes infected. The figures given in previous pages, which, as stated, probably constitute a minimum estimated number of the cases of respiratory disease that can be attributed to the influenza virus in the Army during the World War, show that 26.6 per cent of the men in the military service contracted some form of this disease. The reverse of this proportion is that 73.4 per cent, while equally exposed, escaped infection. It would appear that practically three-fourths of the men, living under conditions as favorable to the transference of infection as can well be imagined, failed to contract the disease. Does this mean that these men were naturally refractory to this infection, that they acquired an immunity at some prior date, or that they failed to come in contact with the active virus? That the lost supposition could be true to any considerable extent in the Army seems too improbable for argument; it might have held some place in the population at large, where the individuals are not in such constant contact with each other and particularly are not habitually associated in relatively large groups. It may be safely assumed for present purposes that practically every soldier had the opportunity to contract influenza if his physical condition was such as to render him susceptible to it. Assuming this, then we are forced to choose for our explanation of the immunity shown by the majority of the men one of the other two possibilities though granting that both may have had their part in producing the effect. The possibility must be borne in mind that many cases may have occurred of such mildness as to have attracted no particular attention, but still leaving an acquired immunity. This is largely an academic distinction, however, as such persons must have possessed marked resistance to the infection, or its manifestations would have been more severe. The disease common among us which in many ways is most like influenza is measles. Immunity to this disease is rarely congenital It is generally admitted that practically all persons are susceptible to it unless protected by previous attack. With measles, however, the immunity conferred by an attack is usually permanent. Bearing in mind the analogy of measles, we should naturally feel that immunity to influenza was most probably acquired and due to a previous attack, but here we find that the question of acquired immunity itself has been called into question.

Earlier writers on the subject were inclined to deny the existence of immunity after an attack of influenza. Parkes[51] in 1870 said, "There is some

discrepancy of evidence; but, on the whole, it seems clear that, while persons seldom have a second attack in the same epidemic (though even this may occur), an attack in one does not protect against a subsequent epidemic." This opinion has been repeated in substantial agreement by many authorities since, and it is a familiar observation that the same individual may have repeated attacks of "grip" from year to year. Whether these repeated attacks are indeed due to the same virus is, as has been said before, still open to argument. On the other hand, it seems necessary to assume that convalescence from influenza involves some degree of immunity, as otherwise we should be faced with a condition wherein each susceptible person would contract attack after attack in rapid succession. Moreover, the usually accepted explanation for the passing of an epidemic wave, that of the exhaustion of susceptible material, depends on the assumption that those who recover from the disease are at least temporarily immune. While we must grant that such immunity in the case of influenza does not last for life, or even perhaps for any considerable period of time, a number of observations were recorded during the World War that tend to throw light on this problem and to make possible a fairly definite answer. First, we have the general observation that troops who passed through the epidemics in the winter and spring preceding the great outbreak of the fall of 1918 showed a decidedly lower attack rate than was the case in the newer troops. To give value to this observation we must assume that these earlier outbreaks affected the Army more extensively than they did the general population. This is a fair assumption, as we have shown that this was true to a considerable extent even in the fall of 1918. We should also have to discount the effect of "seasoning," in so far as this may be shown to be a nonspecific immunizing process, as suggested by the analogy between the effect of service and of relative urbanity of troops, as shown above. Hence the relative immunity of the American Expeditionary Forces, for instance, may have been due more to a nonspecific seasoning process than to the development in its men of a specific immunity. If this be true, it is fair to add that the degree of protection thus afforded is probably as great as could be expected from this process. The average admission rate for the American Expeditionary Forces from respiratory diseases was 143.4 per 1,000, the corresponding rates for the troops in this country was 227.7, a figure about one half again as high as that of the American Expeditionary Forces.[1] If we can show for various units a degree of protection greater than this following a previous outbreak of the disease we shall be justified in assuming that specific immunity entered into the case.

At Camp Shelby, Miss., there was in April, 1918, a division of troops numbering about 26,000.[52] An epidemic of mild influenza struck this camp at this time, and within 10 days there were about 2,000 cases, including not only men who were sent to the hospitals but also men who were cared for in barracks. This was the only division that remained in this country from April until the fall of 1918.

During the summer this camp received 11,645 recruits.[52] In late August, 1918, the virulent form of influenza struck this camp. It confined itself almost exclusively to the recruits of the summer and scarcely touched the men who had

lived through the epidemic of April. Not only the 2,000 who had the disease in April but the 24,000 who apparently were not affected escaped the fall epidemic. Vaughan stated:[53] "It appears from this that the mild form of influenza of April gave a marked degree of immunity against the virulent form of October."

This observation points to the existence of both possible types of immunity: A natural type possessed by the body of the above command that failed to contract the disease on either exposure, and an acquired type in those who passed through the April attack.

The surgeon of the 11th Regiment of Engineers, A. E. F., reports in some detail a parallel occurrence.[54] During May and June, 1918, this organization, already a seasoned body of men, was attacked by an epidemic of influenza which involved 613 men in a strength of about 1,200. There were two deaths from pneumonia. Company B, the unit first attacked, had almost all of the cases for the first two weeks, when the other companies were also attacked. This regiment thus showed an attack rate of over 50 per cent at this time, the company first attacked showing the lowest incidence. During the succeeding five months, the period of greatest mortality from influenza, this regiment was working in the St. Mihiel and Argonne sectors. About 150 men had colds of varying degree, usually attributed to the conditions under which they were living and working. There were 3 cases of pneumonia, of which one died. The regiment thus passed through the worst of the influenza epidemic with practically no sickness. In early January, 1919, the regiment was grouped at Commercy and moved to Bordeaux for shipment home. Here it was again attacked by influenza, then present in the civilian population with a daily mortality of about 1 to 2,000 inhabitants. During January and February there were 270 cases of influenza in the regiment, with 35 cases of pneumonia and 5 deaths.

These cases tabulated by companies with those of the earlier outbreak show that the companies that suffered most in May and June, 1918, had the least disease in January and February, 1919.

	May and June, 1918, influenza	January and February, 1919		
		Influenza	Pneumonia	Deaths
Company A	78	65	9	2
Company B	74	120	18	3
Company C	126	25	4	0
Company D	128			
Company E	123	60	4	0
Company F	84			
Total	613	270	35	5
Percentage of command	51	22		

The regimental surgeon stated: "One feels justified in assuming that the early epidemic had conferred sufficient immunity to keep the regiment free from influenza for six months, and partial immunity extended through January and February." He noted further, that some of the men attacked in the winter had also had influenza in May or June, but as a rule these proved to be mild cases.

Vaughan [53] says: "Those who had influenza in September and October were not affected by the recurrent waves. In the recurrence of influenza at Dorr Field during January, 1919, Squadron A, which was affected most severely in the first epidemic, had no cases. From Camp McClellan we get a report of a similar incident. Speaking of influenza during December, the report goes on to say that Battery A, which had very few cases during the October epidemic, sent more cases to the hospital than any of the other units in this organization, while Battery G, which was affected most during the epidemic, had very few cases this month. Camp Jackson reported a recurrence of influenza in January, which was localized largely in the 48th Infantry, a regiment which had passed through the autumn epidemic with very few cases at Camp Sevier."

An interesting comparison is reported from Camp Dodge, Iowa.[55] In this case the influence of seasoning, or length of service, may be eliminated. There were in this camp at the time of the fall outbreak, two regiments of Regular Infantry. The 2d Infantry had been in Hawaii and there had encountered the earlier wave of influenza, reporting 300 cases. The 14th Infantry, partly from Alaska and partly from Fort Lawton, Wash., arrived in camp during the fall outbreak, with no history of previous exposure to the disease. The 2d Infantry reported influenza in 6.6 per cent of its strength, the 14th Infantry, in 48.5 per cent. They were indeed the organizations having the lowest and highest incidence of all camp organizations, respectively. If this observation be of general significance it would point to the fact that seasoning in regard to this disease is a specific rather than a nonspecific process.

These more or less fragmentary observations might be multiplied almost indefinitely, but enough has been quoted to show that an organization which had passed through one outbreak of influenza was much less likely to suffer as severely a second time, indeed had apparently, for some months at least, received a substantial measure of protection, much more than difference in length of service would imply, especially as in cases like that of the Engineer regiment described above the organizations were already seasoned when the first epidemic appeared. It would appear, however, that in any organization there are many men who do not take the disease in recognizable form, even in a succession of epidemics.

The question of the duration of the immunity acquired by an attack of influenza becomes of great interest at this point. We have seen above that it is the consensus of opinion among authorities on the subject that an attack in one pandemic outbreak is powerless to protect against another attack years thereafter. Some, indeed, as West, think that an attack predisposes to subsequent attacks:[56] "It seems more likely that an individual may never have influenza at all than that having had it once he should never have it again." It appears entirely probable from what has gone before that a definite specific immunity is induced by an attack of influenza. That this immunity is not of long duration appears equally well established. The instance of the 11th Regiment of Engineers serves to illustrate both these points.

THE INFLUENZAL CYCLE DURING THE WAR PERIOD

It was pointed out above that we are apparently justified in assuming the incidence, during the period studied, of seven separate waves of acute respiratory disease associated with pneumonia. The first of these, coming before the mobilization of the National Army, is perhaps the most doubtful and careful studies of its characters are lacking. With the advent in December, 1917, of the second well-defined wave of this character, attention was forcibly drawn to the situation by the occurrence of large numbers of cases of pneumonia with a high mortality. These were at first regarded as secondary to the epidemic of measles which was then on its decline, but as the number of cases of pneumonia continued to increase it became evident that many, if not most of them, had no relation to the former disease. The fact that there were, concurrently, large numbers of cases diagnosed as influenza, bronchitis, etc., was not at the time given the significance that study of the relations between this class of diseases and the pneumonias shows to be its due. Indeed, a comparison between the incidence of acute respiratory disease and the case fatality of measles or with the percentage of measles cases developing pneumonia, shows such a marked degree of correlation that it seems more than probable that even the post-measles pneumonias were due in large measure to concurrent infection with the virus of influenza. Chart XXIII shows these relations graphically. Such a relation would serve to explain the unprecedented high incidence and fatality of measles pneumonia.

It has been shown that groups exhibiting greater susceptibility to infection by the influenza virus also tend to show a greater proportion of lobar pneumonia, while the groups more resistant to the primary infection show increasing proportions of bronchopneumonia. In the gradual evolution of virulence and invasiveness on the part of the virus by which it worked up to the peak of its activity in September and October, 1918, it is probably true that in each successive wave of increasing invasiveness it attacked the most susceptible of the soldiers first, and that each wave attacked men whose resistance could be overcome at that stage of its evolution, leaving those that recovered temporarily immune from later and often more fatal attacks of the disease. With each wave the relation between the virulence and invasiveness of the virus, on the one hand, and the susceptibility or resistance of the population, on the other, determined the incidence and fatality of the disease.

The pneumonias of the first winter (1917–18) of the period under consideration resembled those of the interepidemic period more closely than was the case later, and the proportion of lobar pneumonias was greater than in subsequent outbreaks. Bacteriologically, the findings in pneumonia sputa and lungs varied greatly in different camps. Thus in Camp Travis, Tex., the majority of the winter pneumonias were associated with infection by the hemolytic streptococcus, while at Camp Wheeler, Ga., which also had a very high pneumonia rate at this time, this organism did not make itself felt until the advent of the third or spring wave of infection, the pneumococcus in its various types being found in the pneumonias and empyemata.[2]

It is shown below, in the consideration of the etiology of the pneumonias, that, during this early period, the pneumococci which were found, though exhibiting a considerably larger proportion of the so-called mouth types, Types IIa,

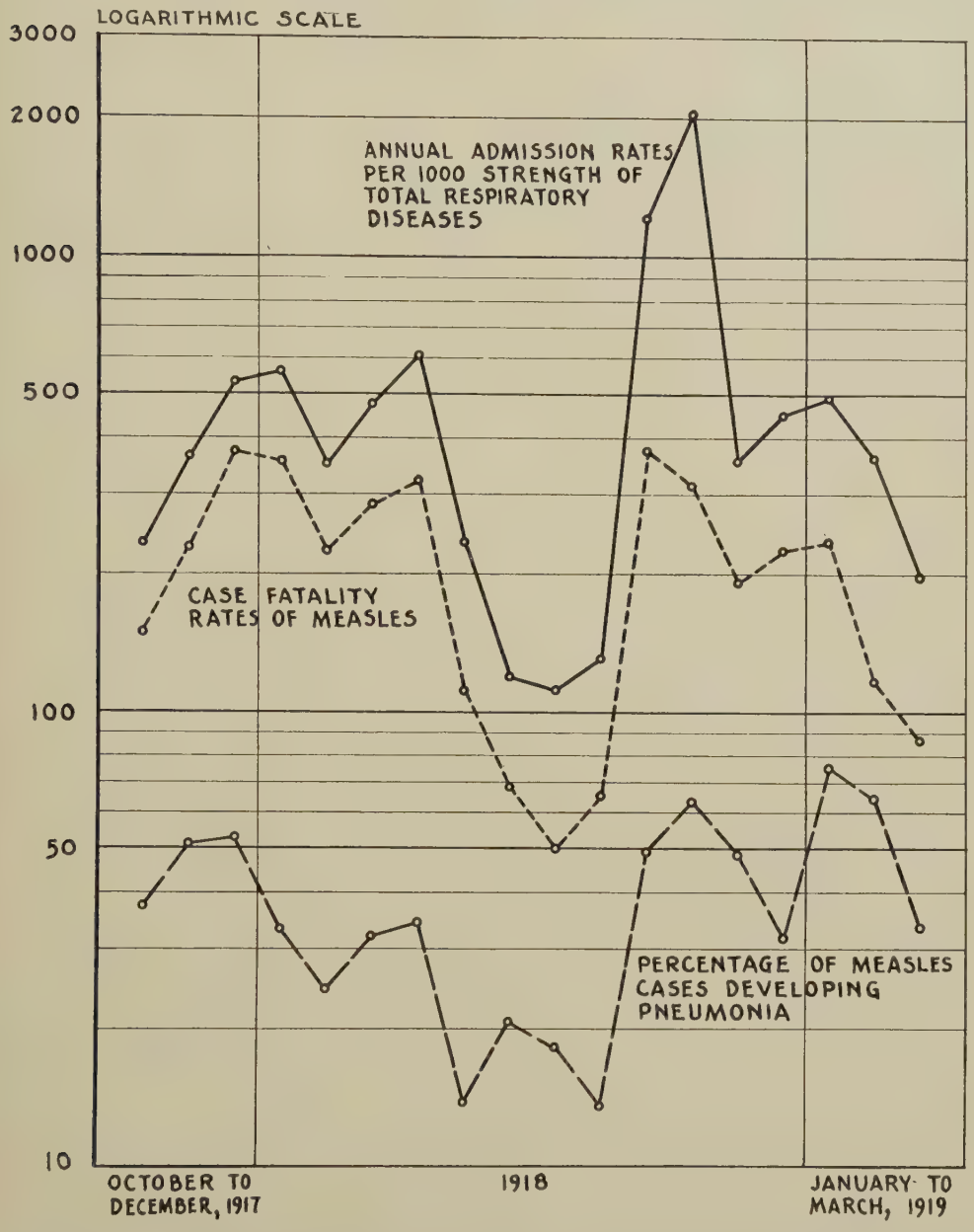


CHART XXIII.—A comparison of the variations in the annual admission rates for the total respiratory diseases, the case fatality of measles, and the percentage of measles cases developing pneumonia, white enlisted men in 36 large camps in the United States, October, 1917, to March, 1919

III and IV, than was the rule in preepidemic times, still showed a much smaller proportion of these types than was the case later when influenza had attained its maximum virulence. The proportion of the fixed epidemic types, I and II,

was correspondingly larger at this time. These latter types are undoubtedly more invasive than the mouth types and so require less predisposition on the part of their victims, while later, when resistance was still more reduced by infection with the more virulent virus, the invasion by mouth types became almost universal.

At this time the high incidence of respiratory disease accompanied by pneumonia obtained among the troops in France as well as in the United States. Though the curve began to rise in both groups at the same time, the peak was reached in the American Expeditionary Forces a month earlier than was the case at home. Our small body of troops in France at this time did not cover as much territory as was the case later and the infection could involve the whole command more quickly than was possible in the widely separated camps at home. Probably for the same reason the peak was higher, though the duration of the outbreak was shorter than in the United States. In both groups at this time the death rates were very much higher for colored soldiers than for white, the disparity being greater in France than at home. The admission rates for colored troops were also much higher abroad but at this time were about the same as those for white troops in this country.

Both here and abroad there was a decided drop in the rates during the month of February, 1918. Taking any one small group, such as a single camp, the interval between waves is seen to be greater than the one month, but owing to the fact that the outbreaks varied in their time of onset and subsidence in the different camps, sometimes by several weeks, the curve for the whole is smoothed and the interval between waves, shortened. In March, 1918, there began to be observed in the United States decided epidemic outbreaks of respiratory disease that was generally called influenza. Descriptions of the disease at this time both here and abroad leave no doubt as to the clinical and pathological identity of the epidemic with that which appeared in the fall. The immunity later shown by groups which passed through this spring outbreak shows that the infection was the same. It was, in most camps, explosive in its onset and it involved a large proportion of the men in each camp attacked, though in the majority, by no means as many as was the case in the fall wave.

Of 36 large camps in the United States, 24 showed a distinct peak of acute respiratory disease occurring either in March or April.[1] The other camps showed increases but in such a way as to divide their cases between the two months. The rates for the concurrent pneumonia present a strict parallelism to those of the acute respiratory disease as is shown in Chart XXIV. Now, too, for the first time, pneumonia was recognized as secondary to influenza in considerable numbers of cases. In several camps, Camp Wheeler, Ga., and Camp Dodge, Iowa,[44] for instance, the character of the secondarily invading organisms showed a decided change, the hemolytic streptococci replacing the pneumococci with increasing case fatality. At this time the fulminating pneumonia, with wet hemorrhagic lungs, fatal in from 24 to 48 hours, was first observed. This was regarded at the time as characterizing the streptococcus at the height of its virulence. Later experience showed the lesion to be influenzal. The 24 camps having a distinct peak month (admission and death rates) are shown in the following tabulation; the month of highest incidence is also indicated for each camp:

Admission and death rates in 24 camps exhibiting a distinct peak month during the spring epidemic of influenza, 1918

	Camp	Month	Admission rate	Death rate		Camp	Month	Admission rate	Death rate
1	Funston, Kans	March	1,907	26.99	13	Greene, N. C	April	775	10.20
2	Wheeler, Ga	April	1,486	12.46	14	Upton, N. Y	March	652	10.37
3	Shelby, Miss	do	1,420	1.50	15	Beauregard, La	April	649	3.72
4	Logan, Tex	do	1,184	2.30	16	Gordon, Ga	do	612	4.66
5	Dix, N. J	March	1,180	7.06	17	Jackson, S. C	do	584	.84
6	Dodge, Iowa	do	1,172	25.80	18	Meade, Md	March	581	1.60
7	Fremont, Calif	April	1,045	.88	19	Lee, Va	April	565	2.70
8	Sheridan, Ala	do	908	3.70	20	Kearny, Calif	do	560	2.40
9	Bowie, Tex	do	896	3.56	21	Sevier, S. C	do	425	3.90
10	McClellan, Ala	do	875	1.70	22	Wadsworth, S. C	do	381	4.83
11	Sherman, Ohio	do	837	8.30	23	Greenleaf, Ga	do	371	.00
12	Doniphan, Okla	March	785	9.22	24	Hancock, Ga	do	284	.93

In this tabulation the camps are arranged in the order of admission rates, beginning with the highest. It is seen that the death rates and admission rates are not closely correlated. If the rates of the camps showing a March peak are compared with those in which the peak came in April, the following figures are obtained.

Month	Number of camps	Death rate	Admission rate	Fatality
March	6	12.9	993	1.3
April	18	3.86	759	.52

Thus the camps having an April peak had nearly as high an admission rate, but much lower death rates and case fatality, than camps having a March peak. This parallels the relation found in September and October, as will be seen later. The order in which these camps were attacked roughly corresponds to the sequence of attack in the fall outbreak. Almost all the camps in the lower half of the table are southern camps. Of the southern camps having high death rates, Camp Wheeler, Ga., Camp Doniphan, Okla., and Camp Greene, N. C., all had high rates during the winter and were evidently composed of highly susceptible material. In this wave, for the first time, men from Northern States were seriously affected.

This wave of the epidemic was very much less explosive in the American Expeditionary Forces.[1] The rise after the February remission was less noticeable and the incidence of influenzal infections with some complicating pneumonias continued well into the summer. The mild character of the disease, together with lack of agreement as to its exact nature led to the designation of "three-day fever," by which it was generally known at that time. The fact that the troops were now widely scattered for training purposes doubtless made its spread less rapid.

It is seen, then, that undoubted influenza appeared at this time in both Europe and America so nearly at the same time as to render its transference from one area to the other very unlikely. That it was present as well in other parts of the world is indicated by a report of the camp surgeon at Camp Kearny, Calif., who attributed the outbreak at that station to the visit of a Japanese fleet which arrived with several cases on board.[57] During the spring epidemic,

both here and abroad, colored troops suffered decidedly more than did white troops. Following the outbreak of March and April there was a marked fall in admission and death rates for respiratory diseases in the United States. As has been stated above, the disease remained sporadically active in France

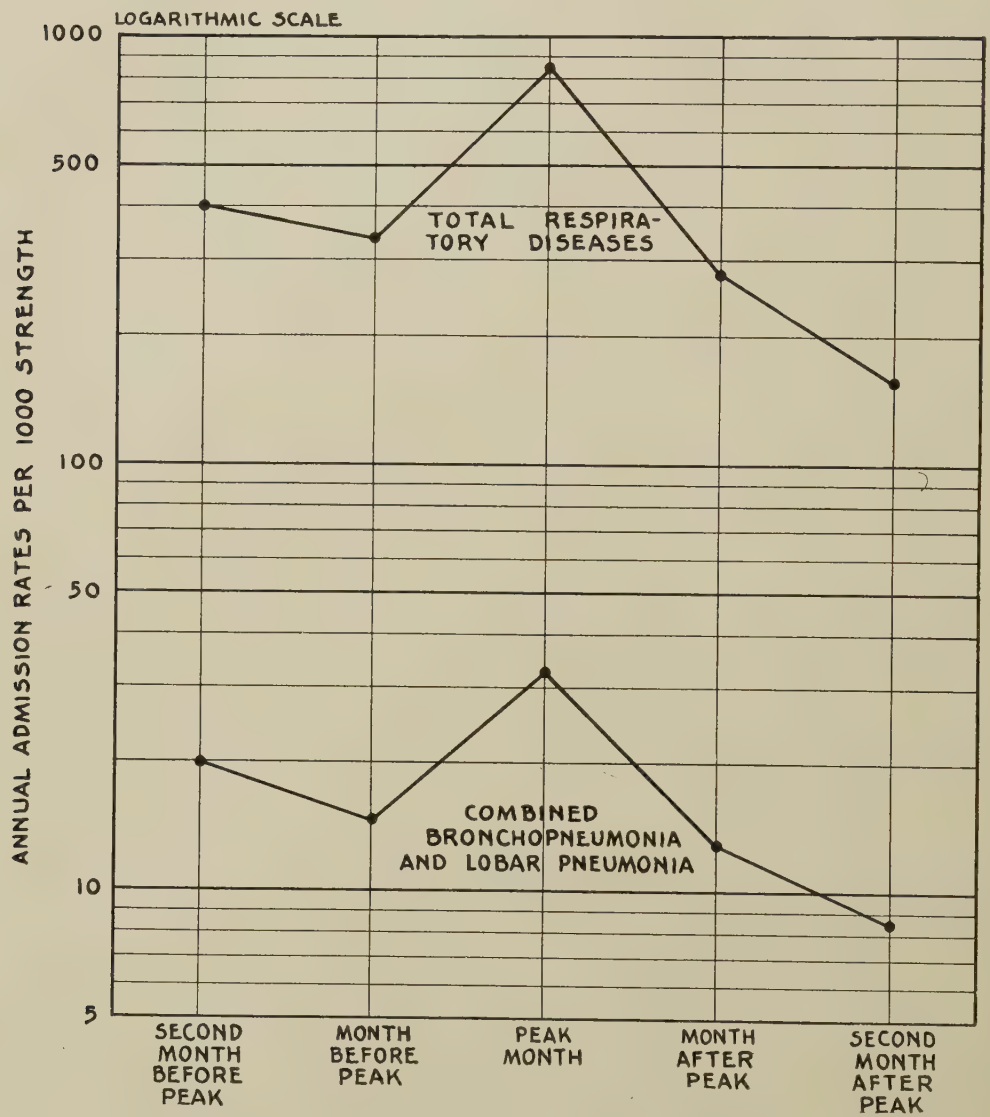


CHART XXIV.—The relation between the total respiratory diseases and the pneumonias, annual admission rates per 1,000 strength for the 24 large camps in the United States which showed a definite peak for these diseases in the 1918 spring epidemic. The figures have been combined so that the peak months in all the camps coincide

throughout the summer. Moreover, in this country there are indications that the disease was not absent but was smouldering, here and there attacking the susceptible individual. This is shown in the occurrence of many cases of pneumonia, even in June, the month of lowest incidence. Whenever a group of susceptible individuals was found there was apt to be an influenzal outbreak

with a varying proportion of pneumonia. The summer of 1918 was one of troop movements on an enormous scale. Camp after camp sent its trained division abroad, and was filled up with recruits. Before leaving, many divisions received recruit detachments to complete their strength. At Camp Funston, Kans., several such drafts were received during the summer, each one within a few days of its arrival in camp being attacked by influenza and pneumonia.[41] These recurring epidemics in recruits were carefully studied by a special board and a full report was published.[41] At Camp Cody, N. Mex., in June, the incoming draft suffered from "bronchitis" and pneumonia.[16] The same sequence was observed elsewhere to a greater or lesser extent. It has been shown above that the rates for influenza and pneumonia began to rise early in August, and increased progressively from that time to the high point in the fall. It is noticeable that the mortality rate of these cases increased through the warm months of the year, when mortality from respiratory disease is at its minimum.

In France, following the spring outbreak, there was a gradual decline in the rates for the American Expeditionary Forces as a whole, individual organizations having sharp epidemics.[1] July showed the lowest rate for the summer. Observers who investigated these different outbreaks expressed the opinion that there was a progressive increase in the severity of the disease as time went on. This is well illustrated by the series of epidemics occurring in the Artillery training camp at Valdahon.[58] To this camp brigades of Field Artillery were sent for special work, one leaving as another arrived. Early in July, 1918, an outbreak was reported here and was investigated by officers from the office of the director of laboratories and infectious diseases, Dijon. This mild epidemic ran its course in a few weeks and the disease subsided until a new brigade entered the post. Within a few days influenza broke out among these troops, affecting especially organizations that occupied the barracks vacated by the companies that had shown the largest number of cases in the first outbreak. As there was little chance for contact between the troops and the permanent camp personnel, it is probable that the virus persisted in the barracks. Later the disease broke out in a third brigade in spite of careful disinfection of the barracks, in this instance being somewhat delayed in its onset. With each outbreak in visiting troops there was an increased number of cases among the permanent personnel. Troops in neighboring towns, even one regiment that marched into the camp daily for firing practice, failed to contract the disease.

That this progressive increase of invasiveness and virulence on the part of the influenza virus was also taking place in the United States is shown by the progressive increase in case fatality during the summer months shown in the general tables and charts. An occurrence somewhat similar to the Valdahon epidemic took place at Camp Shelby, Miss., beginning August 29, 1918.[59] The Shelby outbreak was a sharp explosive one involving, as stated elsewhere, only those men who had not passed through the spring epidemic. It was not as fatal as later waves in the same camp, probably due to the importation of cases from the North, but attack at this time afforded protection against infection with the more virulent strain. There was a decidedly higher fatality than had been observed in the summer outbreaks. This oubreak and the subsequent waves occurring with the advent of new men and practically limited to them are shown in Chart XXI.

This progressive increase in virulence and invasiveness culminated in the explosive outbreak of the autumn wave of disease which reached epidemic proportions early in September and reached its peak in the following month. Again the increase in cases seems to have affected both the American Expeditionary Forces and the Army at home at very nearly the same time. The differences in incidence between the two main portions of the Army, that is, at home and in France, are shown in the general tables and charts. In this country the negro troops showed a relatively lower incidence at this time than before; indeed their admissions throughout this outbreak and their death rate during September were lower than that of the whites. The case fatality, however, in colored troops is consistently higher than that for white troops. Both races showed higher admission and death rates for the country as a whole in October than they did in September. The case fatality in whites was higher in September, while the October fatality was higher in the colored.

It is probable that it will never be definitely settled where the severe and fatal form of influenza arose in the fall of 1918. Each station, with few exceptions, claimed to be able to show that it owed its disease to transmission of infection from some previously affected point. Camp Devens, Mass., the first to report the highly fatal type of the disease,[60] is supposed to have been infected from the city of Boston. The first cases there were on the naval receiving ship at Commonwealth Pier, August 28; thence the disease spread and soon infected the city. It is customary to think of all the subsequent influenza as having spread from this point and in many cases it is possible to trace this spread with some definiteness. There are some facts, however, that tend to the belief that there was a general increase of the activity of an already widely distributed virus which might have given rise to the fatal wave independently of infection from abroad.

Of these facts the first is that already mentioned, that from early August the influenza rates for the Army showed a progressive increase in geometrical ratio, the curve of rise plotting out on logarithmic paper as a practically straight line. (Chart XIV.) The second is the occurrence of definite outbreaks of increasing severity during the summer in this country and especially in the American Expeditionary Forces. These outbreaks ran right up to, if they did not indistinguishably blend with the great fall wave. The case of Camp Shelby, Miss., has been discussed. Camp Logan, Tex., is another camp whose outbreak appears to have been entirely independent of the Boston strain of virus, at least in its early stages.[61] The disease appeared here just two days after its advent at Camp Devens, Mass. There is no known means by which the infection could have been transmitted from Camp Devens, and the disease did not make its appearance in the civil population of Texas for some time thereafter. The possibility of this outbreak having been due to a strain of the virus less virulent than that active in the Northeastern States is indicated by the fact that the fatality at Camp Logan was less than half that at Camp Devens and the further fact that the outbreak is recorded as having been of little severity until the receipt of recruits from the North already infected, who appeared to bring with them a more virulent infection. Camp Cody, N. Mex., had a similar experience in this respect.[62]

Another circumstance tending to support the view that the disease may have evolved its virulent type more or less generally throughout the world rather than that the virulent strain arose in one place and spread by contact, is the apparent impossibility of tracing this spread with any definiteness. As stated above, most stations regarded the disease as imported from without. In the American Expeditionary Forces it was felt that the severe influenza was brought from America. The first of the severe cases at Brest, France, for instance, occurred in a replacement detachment from Camp Pike, Ark., shortly after landing and while occupying a relatively isolated camp of their own.[63] This detachment had left America late in July, 1918, and at a time when the incidence of respiratory disease was near its lowest here. The outbreak was of a severe type, with a high mortality, and for some time was limited to this detachment. Numerous reports of outbreaks in the American Expeditionary Forces during the severe wave express the belief that the disease was introduced by replacement troops from the United States.[64] On the other hand, the general belief here was that the fatal influenza was introduced from Europe through the port of Boston. It is possible, of course, that neither view is correct, but that the fatal strain originated somewhere else and was introduced to both theaters nearly simultaneously. This is suggested by the report that a Norwegian vessel landed several severe cases in New York early in August, having suffered greatly from the disease on her voyage; however, there was no suggestion of fatal influenza in Norway at this time.[65] The fatal type must have evolved somewhere from the less virulent variety. Its essential indentity with the latter is shown by the facts of immunity already recorded. It appears possible that this evolution might have occurred in many places at nearly the same time. An observation along this line is the fact that in several camps in the United States the outbreak of fatal influenza was preceded for several days by increasing incidence of mild cases gradually changing to the severe type. The introduction of a fully virulent virus from without would naturally be expected to produce fatal infections from the start. This transition is described for Camp Sherman, Ohio, as follows:[66]

> At the time the prevailing epidemic was at its height in New England numerous cases of coryza and bronchitis appeared at Camp Sherman. The picture was not characterstic of influenza, but the condition was so frequently noticed among patients at the base hospital that isolation was instituted and special wards set aside for this purpose. The absence of the usual features of influenza led to considerable comment as to the justification of such a diagnosis. This uncertainty was abruptly and definitely terminated by the sudden appearance of large numbers of patients exhibiting characteristics of clinical influenza. * * * By September 24 the transition had occurred.

Somewhat similar observations are recorded for several other camps.

These facts, then—the undoubted general distribution of the disease for months preceding the great outbreak and its progressive increase in prevalence and fatality from early in August, the difficulty of showing with any definiteness where the fatal type originated, and the suggestion in some reports of the development of a severe type locally from a milder strain—render it at least possible, and even probable, that the severe form arose not as a single strain but that many strains acquired increased virulence in different places at about the same time. The question remains unsettled, and more detailed studies of

future outbreaks will be required for its answer. Whichever view ultimately prevails, there can be no doubt that in many stations the disease was definitely introduced from without. Once introduced, the disease spread with characteristic rapidity and involved a large proportion of the command.

Table 27 shows the main facts of the epidemic for the large camps in the United States. It is impossible to give details of these outbreaks. The differences in incidence and fatality, as influenced by various factors, have already been discussed. It is desired, however, to describe the outbreak in one or two camps in order to give an idea of the conditions prevailing and of the difficulties faced, and to a great extent overcome, in the care and treatment of such enormous numbers of very sick men at one time.

TABLE 27.—*Influenza and pneumonia. Admissions, deaths, and case fatality rates, for 40 large camps in the United States during the fall epidemic, 1918*

Camp or station [a]	Epidemic period	Admission			Mortality—Influenza and pneumonia		Case fatality rates, per cent	
		Influenza and pneumonia—absolute numbers	Influenza, per cent of strength	Pneumonia, per cent of strength	Absolute numbers	Per cent of strength	Influenza	Pneumonia
Sherman	Sept. 24–Nov. 19	13,161	33	6.6	1,101	3.3	10.0	51
Cody	Sept. 26–Dec. 12	4,040	44	11.6	240	3.3	7.5	29
Beauregard	Sept. 18–Oct. 20	8,551	53	10.1	410	3.0	5.7	30
Grant	Sept. 21–Nov. 3	13,071	26	5.7	1,060	2.6	9.9	45
Dodge	Sept. 18–Oct. 22	11,931	30	5.8	702	2.1	7.0	36
Forrest	Sept. 29–Nov. 11	3,170	30	5.6	181	2.1	7.2	38
Dix	Sept. 9–Nov. 1	13,733	26	4.0	808	1.8	6.9	41
Devens	Sept. 8–Oct. 29	17,400	33	6.3	787	1.8	5.4	28
Meade	Sept. 17–Oct. 20	14,280	27	6.8	763	1.8	6.7	27
Custer	Sept. 23–Nov. 3	12,773	26	5.9	660	1.7	6.3	28
Jefferson Barracks	Sept. 28–Nov. 2	2,392	29	5.0	119	1.7	5.8	34
Greene	Sept. 22–Nov. 4	5,221	28	3.7	269	1.6	5.9	43
Funston	Sept. 16–Nov. 7	16,983	28	4.6	841	1.6	5.8	35
Humphreys	Sept. 13–Oct. 18	5,408	16	4.4	413	1.6	10.0	35
Syracuse	Sept. 12–Oct. 15	2,761	18	3.6	208	1.6	9.1	44
Upton	Sept. 13–Nov. 30	7,921	22	4.6	432	1.5	6.6	31
Lee	Sept. 13–Nov. 10	13,597	24	3.9	674	1.4	5.8	34
Greenleaf	Sept. 23–Nov. 26	6,159	22	4.2	325	1.4	6.3	33
Bowie	Sept. 26–Nov. 13	5,212	43	6.8	142	1.4	3.2	20
Hancock	Sept. 28–Nov. 4	8,984	22	3.6	499	1.4	6.5	39
Sevier	Sept. 20–Nov. 3	5,422	16	3.1	340	1.2	7.5	37
Taylor	Sept. 22–Nov. 3	14,761	20	4.1	720	1.2	5.9	29
Wheeler	Sept. 30–Nov. 29	2,876	18	4.8	140	1.1	6.1	23
Jackson	Sept. 18–Oct. 16	9,427	22	3.1	412	1.1	4.9	35
Fremont	Oct. 8–Nov. 7	2,778	16	2.5	149	1.0	6.2	40
Eustis	Sept. 25–Nov. 19	2,352	18	2.6	118	1.0	5.8	40
Johnston	Sept. 18–Nov. 1	3,360	15	4.5	165	.95	6.4	21
MacArthur	Sept. 30–Nov. 4	8,354	35	3.3	189	.87	2.5	26
Logan	Sept. 10–Oct. 30	4,947	34	4.0	111	.86	2.5	21
Pike	Sept. 23–Oct. 31	13,124	23	2.5	423	.83	3.6	31
McClellan	Sept. 20–Nov. 8	5,445	14	3.7	228	.74	5.3	20
Kearny	Sept. 24–Dec. 8	5,188	25	3.6	129	.71	2.9	19
Sheridan	Sept. 28–Nov. 4	5,155	20	2.1	145	.62	3.1	29
Travis	Sept. 19–Nov. 9	12,120	28	7.2	199	.58	2.1	8
Wadsworth	Sept. 24–Nov. 4	1,883	10	3.0	80	.56	5.6	19
Las Casas	Oct. 20–Dec. 15	2,403	16	2.8	69	.52	3.4	19
Gordon	Sept. 19–Oct. 31	6,689	17	1.8	166	.46	2.8	25
Lewis	Oct. 9–Oct. 31	3,851	8	2.5	127	.35	4.3	14
Ellington Field	Sept. 30–Oct. 23	1,205	23	1.1	15	.30	1.3	26
Shelby	Aug. 26–Nov. 10	2,803	16	1.5	48	.29	1.9	19

[a] Arranged in order of mortality rate, influenza and pneumonia.

The outbreak at Camp Upton, N. Y., was studied and recorded in a way particularly valuable for epidemiological review.[67] The report states that the disease was brought from Camp Devens, Mass., by troops from that station and began abruptly with the admission of 38 cases on the first day, September 13, 1918. It reached its peak October 4, with the admission of 483 cases, and

then rapidly declined. The following table shows the admissions by days for a period of seven weeks, the percentage of those admitted each day developing pneumonia, and the percentage dying. This classification is particularly valuable in that the cases admitted on a certain day are thus followed to their final disposition, and no allowance for the lag between admission and death is necessary, as is the case when deaths are recorded as of the day of occurrence. This table shows the abruptness with which the disease struck and gives an idea of the problem thrust upon medical authorities in the care of such numbers. It is noted that there is considerable irregularity in the figures for those developing pneumonia and dying. This daily variation is undoubtedly due to the fact that the disease attacked the organizations of a camp seriatim and that certain organizations contained more susceptible material than others. On the days when the admissions were mainly from susceptible organizations the resulting fatality was high, and vice versa.

Grouping the figures by weeks, an interesting relation is developed, thus:

Epidemic of influenza at Camp Upton, N. Y. Admissions by days, and percentage of daily admissions developing pneumonia, and percentage dying

Date	Admissions	Percentage developing pneumonia	Percentage dying	Date	Admissions	Percentage developing pneumonia	Percentage dying
Sept. 13	38	26	10.5	Oct. 4	483	10	3.5
Sept. 14	86	16	10.5	Oct. 5	274	23	5.1
Sept. 15	193	11	5.7	Oct. 6	241	20	8.7
Sept. 16	124	11	3.2	Oct. 7	157	36	9.6
Sept. 17	161	8	1.8	Oct. 8	101	54	16.0
Sept. 18	107	6	4.7	Oct. 9	139	35	10.5
Sept. 19	201	4	1.0	Oct. 10	92	45	13.0
Sept. 20	149	11	3.4	Oct. 11	76	51	3.9
Sept. 21	138	15	6.5	Oct. 12	77	32	5.2
Sept. 22	101	40	15.0	Oct. 13	96	28	7.3
Sept. 23	132	28	10.0	Oct. 14	79	24	7.6
Sept. 24	105	33	11.4	Oct. 15	44	29	2.3
Sept. 25	262	18	4.6	Oct. 16	36	33	25.0
Sept. 26	260	20	7.7	Oct. 17	39	49	10.3
Sept. 27	302	19	6.3	Oct. 18	27	48	0.0
Sept. 28	306	23	7.5	Oct. 19	14	57	7.1
Sept. 29	296	20	5.7	Oct. 20	27	15	3.7
Sept. 30	239	23	7.1	Oct. 21	24	17	12.5
Oct. 1	233	23	6.0	Oct. 22	11	27	0.0
Oct. 2	298	21	6.7	Oct. 23	13	23	0.0
Oct. 3	363	18	6.0	Oct. 24	40	30	5.0

Week ending—	Percentage of admissions developing pneumonia	Case fatality of pneumonia	Week ending—	Percentage of admissions developing pneumonia	Case fatality of pneumonia
Sept. 19	9.6	43.2	Oct. 10	24.14	30.64
Sept. 26	21.1	35.5	Oct. 17	34.23	22.22
Oct. 3	20.66	31.35	Oct. 24	30.13	14.90

It is seen here that as the outbreak progressed the proportion of cases complicated by pneumonia increased, while the case fatality of the same cases became less. This was not due to any change in treatment or to any discoverable change in the bacteriology of the cases. As the whole series was studied by the same men, it is unlikely that differing standards of diagnosis have any bearing, as might often be the case in comparing figures from different sources. Unfortunately, this camp is the only one presenting its figures in such a way as

to allow this kind of a comparison, and it is not known whether this relation between pneumonia incidence and fatality holds generally or is only an accidental happening at Camp Upton.

The following account of the epidemic at Camp Grant, Ill., is introduced verbatim. Though Camp Grant stood fourth in the proportion of fatal cases during the epidemic, its proportion of admissions was not far above the average. It is thought that this account, written by the camp surgeon, will convey in a more satisfactory way than any other an idea of the character of this outbreak and of the difficulties besetting the course of the Medical Department in combating it.[68]

CAMP GRANT DIVISION SURGEON'S REPORT [a]

In the latter part of September a severe epidemic of clinical influenza attacked the camp, resulting in 10,713 cases of this disease during the months of September and October; with 2,355 cases of pneumonia and 1,060 deaths resulting.

The rapidity with which cases developed during the height of the epidemic promptly flooded the base hospital, and it became necessary to equip various infirmaries throughout the camp to receive patients. When the housing space in the infirmaries was filled, one or more contiguous barracks in each area were assigned for the reception of patients. All mild cases were received in the infirmary wards, and if the cases became more severe they were transferred at once to the base hospital. These wards were also used for the reception of convalescents returned from the base hospital, who were held for about a week for observation before being returned to duty. In addition to the observation and attention given the men in the infirmary wards by the surgeons of the various organizations, a medical officer of experience was detailed as visiting consultant. This officer visited each infirmary daily and gave his advice as to which cases should be transferred to the hospital.

The efficiency of the attention given in these wards is attested by the fact that although more than 2,000 cases were handled, but one death occurred in an infirmary and that man was a returned convalescent. As the number of convalescents multiplied, their care became a problem which was particularly acute on account of the lack of a detention or isolation camp. It was solved by granting furloughs to selected men after ascertaiming that their families were able and willing to give them proper care or supervision.

As the infirmary wards began to fill up with convalescents rather than acute cases, it was noted that many of these men had pronounced tachycardia. A cardiovascular specialist was detailed to visit all these wards and report on all cases having heart symptoms, with recommendations. This officer examined all convalescents returning from furlough and made recommendations as to their disposition.

The character of the complicating pneumonia during this wave of the influenza cycle differed only in degree from those observed earlier; the atypical pneumonias of the earlier months became the rule now and, especially in the first few weeks of the outbreak, there were noted cases with pneumonic symptoms of a fulminating character lasting 24 to 48 hours and showing post mortem a characteristic wet hemorrhagic condition with little or no evidence of inflammatory reaction. As noted above, a few cases of this type appeared in the spring wave. They will be described in more detail in the consideration of the pathology and symptomatology of the epidemic. In the later weeks of the outbreaks these fulminant cases became more rare, the fatal cases were ill a longer period of time, and the clinical and pathological conditions observed corresponded more closely with those seen during the preceding winter and spring. Empyema, so common then, was rarely seen in the early weeks of the fall wave, but in the

[a] See also Chap. XIV, Vol. V, of this history for a description of this epidemic in the base hospital.

period of decline of this wave it reappeared with increasing frequency. In general, the pneumonia of this period was regarded as bronchopneumonia, though many cases were recorded as of the lobar type. Possibly differences in diagnostic standards account for this, but in view of the figures already discussed, which show that the proportion of lobar pneumonia increases with the group susceptibility, it is probable that different groups actually showed a difference in the distribution of the two types. The epidemiologist at Camp Devens, Mass., commented at this time on the singular fact that while white soldiers dead of the disease characteristically showed the lesions of bronchopneumonia, colored soldiers succumbing at the same time were equally certain to show a typical lobar lesion.

The bacteriology of this outbreak or wave was extremely varied in different localities and even at any one station. This is later considered more in detail. A point which is of interest in this connection, however, as evidence of the greatly increased virulence of the primary virus at this time is the great prevalence of pneumonias associated with infection by the ordinarily harmless "mouth" type of pneumococci. Though in the earlier periods these types were found more frequently than in interepidemic periods, at the height of the pandemic they appeared to be almost the only representatives of the pneumococcus group to be found. The resistance of the patient was reduced to the point at which these relatively feeble invaders were able to infect.

As regards the different methods employed at different camps in dealing with the enormous numbers of sick during the epidemic period, some surgeons stressed the contagious character of the disease, and every suspicious case showing fever was at once admitted to hospital and isolated. With increasing numbers of cases, many of which developed pneumonia, this necessitated the opening of numbers of barrack buildings as annexes to the hospital, especially for the care of lighter cases and convalescents. Another plan was to admit to the hospital only the more severe cases, those showing more than an arbitrarily designated degree of fever, for instance, the less severe cases remaining under the care of regimental medical officers in infirmaries or in quarters. This plan had the advantage of relieving the hospitals to some extent but was open to the objection that cases of the diseases were scattered among the troops with resultant liability to further spread. At Camp Travis, Tex., a compromise method was adopted consisting in opening a large annex capable of caring for several thousand cases, under the care of a specially organized medical and nursing staff, the annex to be used for the isolation and care of uncomplicated cases, patients developing pneumonia being promptly transferred to the wards of the hospital proper.[70] Though this method would appear the most satisfactory on theoretical grounds, and Camp Travis showed a very low fatality with a large number of cases of pneumonia, consideration of the results in general shows no particular advantage in any of the methods of handling the situation. If, as suggested, later studies should show definitely that the infective period of the disease is mainly limited to the stage of invasion, the explanation of the failure of all these methods to reduce the incidence of the disease will be at hand.

In correlating the epidemiological facts recorded above it may be said that they harmonize with the following conception of the epidemiology of influenza. First, the virus of the disease has a distinct tendency to periodic increases in invasive power, each such increase corresponding to a wave or outbreak of the disease. Between such waves the disease is not entirely absent, but attacks only sporadically. In addition to these changes in invasive power there are changes in the virulence of the infection, once invasion is accomplished. This fluctuation in virulence, if periodic, is of a much longer wave length than that of the fluctuations in invasiveness. The apex of such a wave of virulence corresponds to the outbreak of highest fatality in the course of the cycle. Though the virulence is measured by the proportion of cases developing secondary infections and by the fatality, the degree of invasiveness determines the number of cases attacked in a given outbreak. The disease itself is a comparatively mild one seldom fatal in the absence of definite secondary infection.

This conception would lead us to believe that the earlier waves of an influenza cycle would attack mainly those groups of individuals especially susceptible to invasion either by reason of individual characters, race, or previous environment. In other words, those who had little immunity, natural or acquired. Later waves of increasing invasive power would affect persons of greater resistance, each wave leaving its quota of immunes who are not attacked in later waves. When the invasive power is at its greatest degree of evolution persons most refractory are attacked.

Parallel to the increasing invasive power runs an increase in virulence as manifested by increasing proportions of complicating pneumonia and deaths. In the earlier waves the pneumonias found correspond more nearly to those seen in the absence of influenza, their fatality is less and the characteristic hemorrhagic lesion of the influenza lung is rarely seen. Each case is of longer duration and the spread of infection from the lungs resulting in empyema and other complications has time to manifest itself before the fatal issue. The anatomical type of pneumonia undergoes a change as more resistant groups are attacked, the lobar pneumonias becoming more rare and bronchopneumonia more frequent.

In the earlier waves, groups that are of known susceptibility to the disease were attacked in greater numbers; the fact that the figures for the whole war period show no such marked relation indicates that these groups of susceptibles were early attacked and to a large extent became immune, the less susceptible elements being affected later in greater proportion so that in the end there was little demonstrable difference in the incidence in the different groups.

After the peak of the outbreak of the cycle was passed the persistence of the infection was manifested for some months by the occasional occurrence of typical cases. When the next increase of invasive power manifested itself there was again a certain amount of susceptible material for the virus to attack, because of the short duration of the immunity conferred by the earlier waves, or, perhaps, the fact that possibly not all susceptible individuals, even during a great pandemic outbreak, come into effective contact with infective cases of the disease.

ETIOLOGY

The experiences of the World War have tended to confuse rather than to clarify ideas as to the specific etiology of influenza and, indeed, of the pneumonias as well. Up to the occurrence of the 1918 epidemic the orthodox conception of the etiology of influenza was that of Pfeiffer, whose conclusions were based on work done late in the 1889–1892 cycle of the disease. With the advent of the earlier recognizable waves of the 1918 outbreak it became evident that the bacillus of Pfeiffer was not uniformly present in the cases examined. Certain laboratories reported a high percentage of positive results; others, apparently equally well qualified and equipped, failed entirely to isolate the organism or found it in only a small percentage of cases. Doubts arose as to the specific relation to the disease of the hemophilic bacillus, and it was recalled that this organism had been found frequently during the interepidemic period associated with other diseases—notably measles, whooping cough, and pulmonary tuberculosis—and indeed in persons apparently free from disease. A difference of opinion arose among bacteriologists which still obtains. The development and general use of special media favoring the growth of the Pfeiffer bacillus, such as heated blood agar, or media tending to inhibit growth of other interfering organisms, such media as Avery's oleate-hemoglobin, increased the number of positive findings. The general use of these media, however, came too late for study of the great autumn wave of the disease. It was found also that these media increased proportionately the number of positive findings among non-influenzal individuals. The demonstration by Park and his associates that the various strains of *B. influenzæ* isolated from epidemic cases in New York City were not serologically identical and indeed had little tendency even to fall into groups when subjected to agglutination and absorption tests with specific immune sera, was interpreted by many authorities to indicate that the hemophilic bacilli constitute a group of serologically heterogenous organisms rather than a single species, and that as an epidemic must necessarily be due to the same cause in any given outbreak, it is impossible to assign to the Pfeiffer bacillus the rôle of specific inciting cause of the epidemic.[49] The prevailing attitude with reference to etiology is one of agnosticism, and until further work either produces conclusive evidence in favor of the Pfeiffer bacillus or presents some other organism for consideration as the cause of the disease, opinion on the subject will remain unsettled.

Various investigators have suggested a number of other organisms as the cause of influenza. The one which has received the most attention and which has been found in outbreaks not only in this country but also in Europe is a Gram-positive diplostreptococcus producing a green coloration on blood agar and seeming to partake of the characteristics of Group IV pneumococci and of hemolytic streptococci of the alpha type, if not actually a mixture of these organisms. All of the objections to the acceptance of the Pfeiffer bacillus as the cause of the disease apply with equal or greater force to this apparently heterogeneous group.

The bacteriology of the pneumonias throughout the course of the World War was also unsettling to preconceived ideas of the causation of the disease. At the outset the idea was generally accepted that the majority of cases of

pneumonia were due to pneumococci of the so-called fixed types. It soon was proven, however, that not only were the pneumococci of the mouth types found in a much greater proportion of cases than was expected but also that other organisms, notably the hemolytic streptococcus, were associated with pneumonia in large numbers of cases. The technique of typing the pneumococcus was new to many laboratory workers, and the shortage of mice rendered it often necessary to fall back upon the blood-broth culture method of Avery, which has the disadvantage of failing to distinguish between virulent and avirulent organisms. However, the compilation of available figures from the months before the fall (1918) epidemic of influenza shows that 1,903 cases were reported from 29 different sources.[71] These cases may be tabulated as follows:

Types of pneumococci reported from the camps in the months preceding the fall outbreak of influenza

Type	Cases	Percentage of total	Type	Cases	Percentage of total
I	349	18.2	III	106	5.5
II	278	14.6	Group IV	935	49.0
II (atypical)	235	12.7			

Inasmuch as most of these reports did not distinguish between the true and atypical types II it is probable that the proportion of the former should be considerably smaller and the latter correspondingly larger. About a third of the cases were charged to the strictly epidemic types of the pneumococcus. There were differences between camps in type distribution that can be accounted for neither by the care exercised nor by methods employed. It frequently happened that the same camp reported striking changes in the proportion of the types found from month to month.

As time went on and workers gained proficiency in the method of typing it was expected that the proportion of the fixed types would tend to increase. As a matter of fact the reverse was true. Reports on the types found during the months of September and October, 1918, show a still greater incidence of the mouth types of pneumococci.[71] A tabulation of 2,617 cases from various sources is as follows:

	Cases	Percentage of total		Cases	Percentage of total
Type I	82	3.1	Type III	199	7.6
Type II	145	5.5	Group IV	2,090	79.9
Type II (atypical)	101	3.9			

Not only were the pneumococci of the heterogeneous group predominant but other organisms were encountered in association with them in various places and at different times during epidemics of pneumonia. Of these associated organisms, the most important was the hemolytic streptococcus. This organism appeared early in some camps as the exciting cause of postmeasles pneumonia, more fully treated elsewhere. Not all camps having a high incidence of pneu-

monia after measles were able to attribute it to this organism. The facts with regard to the postmeasles pneumonia at Camp Wheeler have already been stated. Camp Travis, on the other hand, at the same time had a large proportion of these cases due to streptococci. It would appear that given the necessary predisposition in the form of primary infection, the actual exciting cause of the pneumonia will depend upon the predominance of one organism or another in the environment or upon the mucous membranes of the patient himself. This idea is supported by the fall outbreak in which most stations reported their pneumonia as of group IV pneumococcus origin but some attributed all their fatalities to the hemolytic streptococcus. During this time reports attributed pneumonia to still other of the usual flora of the mouth such as the streptococcus viridans, the staphylococcus (Camp Jackson),[72] and the pneumobacillus of Friedlander (Walter Reed General Hospital).[73]

The relation of pneumonia to the incidence of influenza has been shown. If, as seems certain, this is a true causative relationship, the influenza acting as the predisposing cause which rendered the pneumonic infection possible, it would appear that the earlier, less virulent waves of the epidemic were complicated by the more invasive of the pneumococcus types while, as the influenza itself became more virulent, it further reduced the resistance of its victims so that the ordinary mouth types were increasingly able to infect, and also such ordinarily inactive organisms as the staphylococcus, the hemophilic bacilli, etc. The hemolytic streptococcus, and organism of low invasive power combined with high fatality, invaded those camps first where for unknown reasons it happened to predominate. Later with the general interchange of troops between camps it became more widely disseminated. So far as the records show there is no instance of an outbreak of pneumonia due to this organism that was not coincident with an outbreak of influenza or of some acute respiratory disease that might readily be regarded as of influenzal nature.

It has proven impossible to estimate the number of cases of primary pneumonia that occurred in the Army during the war and it follows that no separate study of its etiology is possible.

PATHOLOGY

As was stated in the introductory paragraphs of this chapter, there is evidence in the findings at autopsy of patients dead of pneumonia early in the war period that some influence was at work tending to the production of findings at variance with the usual experience in the pneumonias of the interepidemic periods. That this influence was, at least in great part, the presence and activity of the increasingly virulent infective agent of influenza has been shown with some degree of probability. The nonfatal character of uncomplicated cases of influenza renders a description of the anatomic changes produced by that disease alone an impossibility. The autopsies were necessarily all held on the cases of men who had suffered fatal pneumonic complications. This situation renders it necessary to consider the subject of pathologic anatomy from the same standpoint as that of epidemiology. The pathology found in cases of influenzal pneumonia will be described and the attempt made to deduce the changes in uncomplicated influenza, at least of the more severe type, by first, noting those

characteristics in which the pneumonias of the influenza period differ from those usually observed in the absence of an epidemic, and second, paying particular attention to the findings in those fulminant cases of very short duration in which secondary infection, if present, had apparently not had time to produce recognizable anatomic effects.

The sources of information drawn upon for this study are various. The unusual character of pneumonia very early led to careful studies on the part of hospital staffs, and to the publication of numerous reports. A special board of officers studied the condition at Camp Travis in the late winter of 1917–18, and later made observations at Camp Dodge, Iowa.[74] Another board worked during the summer mainly at Camp Funston, Kans., and during the fall wave of the epidemic at Camp Pike, Ark.[75] Special reports of the pathology during the last-mentioned outbreak have been published by officers at a large number of camps. An especially comprehensive study of the subject was made at New Haven in connection with the Army Laboratory School at Yale University.[76] Reports of the conditions found at autopsy in our forces in France were received from practically all large centers in response to a circular letter from the office of the director of laboratories and infectious diseases, dated December 17, 1918. Material from all these sources has been utilized in the attempt to draw a comprehensive picture of the changes found in these pneumonic cases, not only during the great fall epidemic but in the earlier months as well.

It is stated elsewhere that clinicians found nothing in the pneumonias of the months before late November, 1917, that struck them as being different from the findings of the interepidemic period in civil life. With the occurrence late in 1917 of the definite wave of acute minor respiratory diseases, which was in general coincident with the declining period of the great measles outbreak, the atypical forms of pneumonia began to make their appearance in increasing numbers. Cases in increasing proportion were recognized by the clinicians as bronchopneumonia rather than lobar pneumonia, and this proportion was still further increased by the results of post-mortem examination. Briefly, the findings at this period were characterized by their variability. In any given camp there was a tendency for one finding to predominate, but in no report is it shown that the pneumonias examined ran true to any one type in even the great majority of cases. The details found appeared to be somewhat dependent on the nature of the bacteria associated with the process. But there was everywhere considerable diversity in the bacteria found. Two outstanding facts were easily noted at this time: First, the fatal cases were characterized by a very large proportion of secondary or metastatic invasions of the serous membranes, particularly the pleuræ, producing highly fatal empyemata; second, the high incidence of pneumonia was largely confined to camps which were made up of men from the States of the south and southeastern part of the country, States whose men had been shown by Civil War figures to be far more susceptible to the respiratory diseases in serious form than those of the north and west.

In more detail, the report of the commission at Camp Travis showed that anatomically the pneumonias might be classified into true lobar pneumonias associated with pneumococcus infection; interstitial bronchopneumonia

in which the infection appeared to spread through the bronchial walls for some distance in the interstitial tissue of the lung, producing peribronchial nodular consolidation; lobular pneumonia, in which groups of lobules showed consolidation due to filling with polynuclear leucocytes; and mixed types showing two or more of the varieties described. The interstitial and lobular varieties were associated with infection by hemolytic streptococci and the lobar type usually with pneumococci. The influenza bacillus of Pfeiffer was found in a considerable proportion of cases but was not regarded as of primary importance.

Reports from Camp Funston at this time showed substantially the same conditions.[77] In both camps (Travis and Funston), as indeed wherever fatal pneumonia prevailed, the incidence of suppurative complications, especially empyema and, to a less extent, peritonitis and pericarditis, was high and was responsible for a large proportion of the fatality. At Camp Funston in particular, a form of mediastinal abscess, "subcostosternal abscess" was noted post mortem with great frequency. These serous membrane suppurations were commonly of streptococcus origin. They occurred, however, in pure pneumococcus infections, though with less frequency. In general it appears possible to make the statement that at this time, of the camps showing a high incidence of pneumonia, those with the greatest fatality showed the highest proportion of the lobar type of the disease.

Reports of the pneumonias occurring with the spring (1918) outbreak of influenza showed an increasing proportion of the types of bronchopneumonia, though typical lobar pneumonia still appeared. At this time the number and character of influenza cases forced attention to this disease at most camps. On the other hand, at Camp Dodge, Iowa, for instance, while the medical authorities there reported the coincidence of large numbers of cases of mild tracheitis,[78] McCallum,[79] who studied the outbreak, stated that the majority of the cases could not be shown to be related to any recognizable previous disease. This shows that even when looking for such an occurrence it is possible to fail to recognize the existence of the primary infection. That the reported cases of mild tracheitis at Camp Dodge were in fact influenza, and the pneumonias of that period were influenza pneumonias will hardly be questioned at this time in view of the experience of other camps during the same months and the subsequent evolution of the pandemic. If more definite proof were needed, it may be found in the description of the pathology of the pneumonias studied. In general the findings parallel those of the previous winter at Camp Travis. Certain changes are noted that appear very significant in the light of later events. The proportion of lobar pneumonias was smaller, as was that of the interstitial type of bronchopneumonia. Lobular pneumonia predominated, often confluent. Serous membrane infections, while frequent, were present in a smaller proportion of autopsies, as patients were more apt to die before these complications had time to develop. "At necropsy there was found the most intense congestion of the entire respiratory tract." The bronchi "were markedly dilated toward the periphery; their mucosa was deep purplish gray." "Great hyperemia and edema of the bronchial wall is seen accompanied by a less evident new formation of connective

tissue cells. The adjacent alveoli so far as they are not filled with red blood corpuscles, are packed with mononuclear cells and dense fibrin. The alveolar walls are infiltrated with mononuclear cells and are widened." Large necrotic areas were noted, eventuating in abscess formation and containing enormous numbers of streptococci. Perhaps most interesting in evidence of the influenzal character of the disease was the occurrence of the hyaline change in the lower third of the rectus abdominis (Zenker's degeneration) in two cases with rupture of the muscle and hematoma. All these points are so characteristic of the pneumonias of the fall outbreak, unquestionably influenzal in nature, that their occurrence at this time in the presence of the epidemic of "mild tracheitis" serves to clear up the character of that infection.

With the passing of this wave of infection the type of pneumonia recorded was predominantly lobar until the advent of the highly fatal wave in September. The following brief account of the findings in the latter wave, during which the influenza manifested itself at the height of its virulence, is necessarily a composite, culled from many published and unpublished articles and reports. In the interpretation of the findings with regard to the part played by the influenza virus in the production of the picture as well as that played by secondary invaders it is necessary to consider in particular two factors with regard to any given case. These are the duration of the disease before the fatal ending and the stage of the epidemic wave at which the onset of the disease occurred. In the consideration of the varied pathology of the epidemic it is necessary to divide the cases into certain groups which are fairly difinitely correlated with the variations in the two factors mentioned.

The first group of cases showing best, post mortem, the lesions which will be interpreted as characteristic of the primary influenzal infection, has been called the "wet, red lung" type, or hemorrhagic pneumonitis. It occurred typically in the earlier part of any given outbreak, and then usually in cases of less than average duration, often of only two or three days. A second group, comprising a majority of deaths during an epidemic, showed various pneumonic lesions on a hemorrhagic background. These occurred in cases of somewhat less initial severity than those of the first group and life was prolonged sufficiently to allow the lesions of secondary infection to fully develop. These cases was found in greatest proportion during the height of the outbreak and showed an average duration decidely longer than those of the purely hemorrhagic type, even as much as ten days or two weeks. The type of consolidation encountered in this group varied greatly according to the location of the troops involved, according to race, and possibly to other factors. Extrapulmonary suppuration, such as empyema, was rare, although fibrinous pleuritis or pleuritic effusion were often reported. Still later, in an outbreak, a third type of cases came to autopsy. These were usually cases of still longer duration and in them the hemorrhagic features were much less noticeable. So also the acute pneumonic consolidations were not so constant, but evidence of their former presence was at hand in the shape of unresolved pneumonia, organization of exudate, pulmonary suppuration, interstitial or in the form of abscess, and secondary suppuration of the serous membranes. This last group then resembled most closely those of the previous winter, those of the second group the more acute cases of

the spring outbreak, as described by McCallum,[84] at Camp Dodge, while the hemorrhagic group was represented in the spring outbreak by the rare cases of the type already mentioned. These different types must be the result of the interaction of the virulence of the virus on the one hand and the degree of resistance of the persons attacked on the other. As both factors are variables all types of pneumonia were produced during the evolution of the influenza cycle and in any one outbreak graduations from one type to another were encountered and mixed types were frequent. Bearing in mind the above facts of distribution we may continue to the more detailed description of the types of pulmonary lesion found.

The wet red lung or hemorrhagic pneumonitis gave a picture almost pathognomonic of acute influenzal pneumonia. The only comparable findings are those of pneumonic plague and those seen in acute death from toxic gas. On opening the thorax the first point noted was the almost total failure of the lungs to collapse. On removal the lung retained on the table its natural size and shape. The pleuræ usually contained a little blood-tinged fluid, rarely any considerable amount. The pleural surface was usually smooth and glistening, though a thin layer of fibrin over areas of greater density was not rare. The pleural surface of the lung was brilliantly mottled throughout with different shades of red, from the pale pink of emphysema through the bright color of recent hemorrhage to the deep purple of venous blood. This mottling was lobular in distribution, contrasting colors often showing in adjacent lobules. There were usually considerable areas of definite emphysema, especially along the anterior borders. The posterior portions, especially of the lower lobes, showed the darkest coloration, but the changes described usually involved all the lobes to some extent.

On section of such a lung, large quantities of bloody serum escaped from the cut surface, usually containing small bubbles of air. It seemed impossible to dry the surface by scraping. Portions cut from the lung usually barely floated in water; some sank. There was seldom any distinct nodular feel to the lung, though some portions were evidently more solid than others and the cut surface of such areas presented a meaty appearance very similar to that of a recent hemorrhagic infarct. The entire tracheobronchial tree was intensely congested, of a deep velvety red, spotted here and there with foci of a darker or more intensely red color. The bronchi contained a thin seromucous blood-stained fluid and the bronchioles, especially peripherally, were distended and prominent. Rupture of these distended bronchioles was associated occasionally with interstitial emphysema, usually confined to the lung, but more rarely becoming generalized subcutaneously. The extent to which the lung was involved in this hemorrhagic and edematous process was at times incredible and was plainly of itself incompatible with life. The condition was characteristically diffuse involving as a rule all the lobes to a greater or lesser extent.

Histologically the tracheobronchial lesions were prominent. In the trachea the mucosa was always to some extent destroyed, and large areas were denuded of epithelium. Such areas were covered by an exudate composed of red blood cells, mucus, and small amounts of fibrin. The exudate was rarely adherent or diptheritic in character. The submucosa showed a marked degree of edema,

congestion, or even rupture of blood vessels with hemorrhage. In the earlier cases at least there is no sign of leucocytic reaction. The same general findings apply to the bronchi and bronchioles to an even greater extent. The epithelium becomes hyaline, loses its nuclei, and is frequently desquamated. The vessels of the submucosa are dilated, project into the lumen, and often rupture. The muscularis may be involved with loss of nuclei and hyaline change. (It seems probable on clinical grounds that in many cases the disease may be limited to the trachea and bronchi so far as pulmonary extension is concerned.) Wherever sections of the lung are taken for examination the conditions found are much the same. There is a general edema. Subpleural spaces, interstitial tissue, alveolar walls, and alveoli are all involved in this process. The characters of the exudate are best seen in the alveoli where it sometimes appears as a homogeneous mass resembling colloid, sometimes as finely granular material, and sometimes containing strands of fibrin. Varying numbers of red blood cells are present in this fluid from a scattered few to densely packed masses indistinguishable from a recent infarct. In some cases large numbers of bacteria are found throughout; in others careful search fails to reveal their presence. In these early cases polynuclear leucocytes are conspicuously absent. Slightly later, lymphocytes and large mononuclear cells are prominent in certain areas.

Winternitz and his coworkers state that[76] "The acute death which involves the tracheal, bronchial, and bronchiolar epithelium and which may extend beyond the epithelium into the walls of these structures and kill en masse the walls of the alveoli is a lesion which does not occur in other types of pulmonary infection." In influenza it is the lesion of characterization. In addition the aplastic reaction of the lung characterized by edema, hemorrhage, and lack of leucocytic response produce a pathologic picture in these fulminant cases that will hardly be confused with that of any other disease. Certain details have been emphasized by different students of the condition which deserve mention. Le Count[80] called attention to necrosis of the walls of the pulmonary capillaries. Wolbach[81] regarded a peculiar distribution of a hyaline fibrinlike substance on the walls of distended alveoli as characteristic of the disease. Most reports mention a tendency to hyaline thrombi in lymphatics and in smaller arteries and veins. The broad general characterization of the process, however, as showing evidence of a toxic injury of the tracheobronchial epithelium, the process extending entirely through the walls of these structures and accompanied by an aplastic inflammation of the pulmonary parenchyma with marked generalized edema and hemorrhage, suffices to define the findings.

The findings in later cases show various types of pneumonic consolidation on a background of varying degrees of the condition just described. In these cases the power of reaction on the part of the tissues appears to have been at least partially restored. Lobar, interstitial, and lobular forms of pneumonia, with exudation of polynuclear leucocytes and often fibrin into the consolidated areas, characterized this group, the appearances differing from those found in the earlier months by reason of the greater prominence of the hemorrhagic and edematous background upon which the inflammatory process was superimposed. The existence of the true lobar type of consolidation during this epidemic has been questioned by many but the following statement on the subject from the report of the Camp Pike commission should prove conclusive:[13]

The pulmonary lesion has been designated lobar pneumonia when it exhibited the well-known characters of this lesion, namely, firm consolidation of large parts of lobes, coarse granulation of the cut surface, fibrinous plugs in the bronchi, and on microscopic examination homogenous consolidation and fibrinous plugs within the alveoli.

This commission found lobar pneumonia in almost half their autopsies. Everywhere various combinations of the different types of pneumonia were found and in different localities different types predominated. It would appear that, in general, the lobar type of the disease was associated with pneumococci, the interstitial type with streptococci, the lobular type with streptococci or the Pfeiffer bacillus, and a type characterized by small peripheral abscesses with the staphylococcus. Exceptions to these rules are so numerous, however, that definite conclusions may not be drawn from the anatomical findings. Pneumococci may be responsible for either lobar or bronchopneumonia. An especially interesting point, perhaps bearing on the pathogenesis of these conditions, is found in the report of the Camp Pike commission.[13] Cultures, post-mortem, were taken from the bronchi, lungs, and heart's blood. In cases of bronchopneumonia of pneumococcus origin the percentage of positive findings in the bronchi considerably exceeded that in the blood while in pneumonias of lobar type the reverse was true. This may be evidence of a different route of infection in the two types.

A detailed description of the various lesions observed in these pneumonias is not in place here. Suffice it to say that as the cases occurred later and later in the epidemic their type more and more nearly approximated those of the earlier months, showing increased pneumonic consolidation and less prominence of the hemorrhagic and edematous condition. Secondary suppurations became more frequent. The same characters were found in the pneumonias of the recurrent waves, including that of the early months of 1920.

It appears impossible to attempt a statistical analysis of the variations of pathologic type between different stations or geographical divisions. The impression is gained from the study of numerous reports that the lobar type of the disease was more generally reported from the southern camps than from the northern. The reports of the hospital centers in France while showing the same diversity of findings, indicate the relative infrequency of lobar pneumonia among the troops in that country. The reports seldom divide their cases according to race, but that the same preponderance of lobar pneumonia in the negro that is noted in the admission and death rates also held in the post-mortem room is suggested by the comment of the epidemiologist at Camp Devens already quoted.

While, post mortem, the pulmonary lesions assume commanding importance, from the epidemiological standpoint, the lesions of the upper respiratory tract are perhaps of greater significance. The nearly constant pharyngitis is emphasized clinically. Involvement of the accessory sinuses of the nose, especially the sphenoidal, was reported with great regularity by pathologists who looked for the condition. The early conjunctival inflammation observed clinically is perhaps related to the upper respiratory tract infection or may possibly represent the atrium of infection.

Of changes outside the respiratory tract, few appear to be of significance in influencing the outcome of the disease. A possible exception is the lesion

in the adrenal recorded in several reports. This appears to have been of a hemorrhagic nature, with loss of the lipoidal contents of the parenchyma cells. Some observers have connected this lesion with the prostration so characteristic of the disease. Of other changes, particularly emphasized in the reports, the occasional occurrence of interstitial emphysema, in some cases involving a considerable part of the body surface, and the hyaline degeneration rather commonly observed in the lower third of the rectus muscle with frequent rupture and hemorrhage, have already been dwelt upon. The degenerations of the parenchymatous organs, though often extreme were in general those seen with any severe toxemia, although focal hemorrhage apparently due to lesions of the vessel walls were not uncommon. Of suppurative complications, seen mainly in cases of relatively long duration, empyema, peritonitis, pericarditis, and meningitis occurred with varying frequency.

ROENTGENOLOGY

The result of systematic examination of cases of influenza and pneumonia by means of the X ray has been exceedingly valuable, not only in enabling the clinician to greatly increase his knowledge of the progress of the disease in the individual patient, but also in throwing much light on the nature of the early changes taking place in the lungs, especially in cases of uncomplicated influenza in which other methods of exploration of the chest are impossible. Thus the subject of roentgenology might be considered appropriately either under the heading of clinical medicine or under that of pathology. It seems best to consider the X-ray findings themselves with occasional comments as to the interpretation that seems justified or the special clinical value of the observations.

One of the most important questions put to the Roentgenologist for answer was whether or not early uncomplicated cases of influenza show any demonstrable pulmonary changes. The majority of cases give no evidence of such involvement on physical examination, or at most a few scattered râles usually interpreted as bronchitis. The important question was: Does the generalized hemorrhagic and edematous condition found post mortem in fatal cases exist in uncomplicated influenza cases without pneumonic consolidation; and if so, to what degree? The answer to this question is important in the interpretation of the post-mortem pathology, in the study of the pathogenesis of the complicating pneumonias, and consequently in the development of means of preventing these complications. In several hospitals careful X-ray studies were made and reported, which appear to answer this question quite definitely. The method adopted was to take daily, serial plates from a large number of cases from admission to recovery or death. In some cases control plates, taken previous to the onset of the disease, happened to be available. The results of these studies on cases, clinically without signs or symptoms of pneumonia, are summarized in the following quotation from the report of two investigators at Walter Reed General Hospital:[82]

> On examination of the radiograms there is seen to be a general increase of density throughout the lungs. This density may be described as being of a hazy or smoky nature, which decreases the contrast between the normal lung transparency and the bronchial tree outline. This generalized density is somewhat greater from apex to base, to the inner half

and especially adjacent to the mediastinal border, thus obscuring to some extent the mediastinum and cardiac outline. The most marked changes are seen in the bronchial structures themselves. A greater number of vessels are seen than is usual in any other disease. They are more definite, although diffuse in outline. This peribronchial thickening, however, is seen most markedly around the hilus, extending outward in "sunburst type" and rapidly diminishing in size from the hilus to about the outer one-third of the lung. The peribronchial thickening extends upward parallel to the mediastinum and helps to obscure the mediastinal outline. The greatest thickening and the greatest diffuse bronchial density are seen at the base, extending downward from the hilus, reaching the diaphragm outline and extending to just beyond the midclavicular line.

In cases where influenza progressed as influenza toward recovery there is a gradual diminution, first, in the hazy generalized density and then in the diffuse density of the bronchial structure. The density around the hilus due partly to peribronchial thickening remained considerably longer. The hilus becomes affected very early. There is an immediate enlargement of the hilus and marked increase of density with irregular outline, so much so that in no case is there any question of the reaction of the hilus. The irregular outline is due to bronchial thickening.

The conditions outlined above obtained in the case of average severity, without signs of pneumonia. When present in slight degree, as in unilateral cases, or in cases showing a little more than the enlargement of the hilus structures, the clinical severity of the case was invariably slight and the return to normal was rapid.

Certain cases of average severity, however, showed on physical examination persistent râles at either base. At Fort Sam Houston, Tex., 25 per cent of 1,000 cases of uncomplicated influenza gave this finding.[83] There was no other evidence clinically of anything resembling pneumonia; however, X-ray plates showed local areas of increased density corresponding to the physical signs in practically all of this group. This finding is probably to be interpreted as an early or slight example of the lesion described from Walter Reed General Hospital as "hemorrhagic pneumonitis." This condition was correlated definitely with the hemorrhagic infarctlike consolidations discovered post mortem. It showed on the plates as a denser, smoky opacity obscuring the bronchial outlines, beginning at the hilus and extending peripherally. It may involve all the lobes, but is seen most often in the lower. This shadow differs from the shadows of pneumonic consolidations both in distribution and in lesser density. Unless of considerable extent this condition gives no physical signs other than the persistent râles mentioned; however, when its increase in extent reaches the surface, the signs produced are those heard early in pneumonic involvement and before classical signs of consolidation are established. Not all cases showing this type of consolidation eventuate in definite pneumonia, but in cases showing such involvement of a large proportion of pulmonary tissue the usual outcome is pneumonia, or, in the most severe cases, death, with lungs showing only the hemorrhagic and edematous type of lesion. The X-ray evidence, then, shows that some degree of pulmonary involvement is present in practically all cases of influenza, evidenced by a hazy opacity generalized throughout the lung, and a thickening of the bronchial structures and increased density of their shadows. This finding corresponds well with the generalized hemorrhagic and edematous lesion of the bronchi and parenchyma described on post-mortem examination for cases dying early, and justifies the belief that substantially this condition in varying degree exists in milder cases that recover without complication.

With the advent of definite secondary infection the plates show a great variety of pictures. Briefly, the bronchopneumonic consolidations tend to begin near the hilus, to show first as a dense peribronchial thickening, with later nodular shadows grouped along the bronchi in such a manner as to suggest the "pussy willow." Still greater extension results in confluence and the production of massive shadows resembling those of lobar pneumonia. When resolution occurs it progresses from the periphery toward the hilus, in inverse order of occurrence. Lobar consolidation shows almost simultaneously throughout the area involved, with a tendency to peripheral involvement first and resolution is first central, the peripheral portions retaining the shadow to the last. Interlobar pleuritis is frequently demonstrated by the X ray when no physical signs are to be discovered. It shows as a fine almost hairlike line in the anatomic location of the fissure involved. Pleuritic fluid and empyema give the well-recognized pictures of these conditions.

Daily X-ray examinations show that the consolidations, especially those of the purely hemorrhagic type, vary greatly in extent from day to day, spreading and receding to spread again sometimes over the same area as before. These advances and recessions of the anatomic process are usually well correlated with the temperature and other clinical evidences of the intensity of the disease process.

In general it may be said that the X-ray plate often, if not usually, furnishes the first indication of the onset of complicating pneumonia. With resolution, the final clearing of the lungs from the X-ray and clinical standpoint is often not simultaneous. In some instances when the physical signs persist after the plate shows return to normal, the patient is said to feel and appear perfectly well. In the other group where the X ray shows pathology after physical signs are negative the patient has rarely completely recovered from the symptomatic standpoint. It would appear from this that the radiographic evidence of recovery was the more dependable.

CERTAIN CLINICAL ASPECTS

In the consideration of the clinical aspects of the respiratory group of diseases dealt with herein, only such features are touched upon as represent advances in knowledge during the World War, or as are of especial importance in the recognition or treatment of the conditions described.

A knowledge of the exact limits of the period of incubation is not easy to obtain, owing to the great prevalence of the disease when present. That the period is very short is generally conceded; that it may be of several days' duration, however, seems probable from certain reports, especially those which mention a period of malaise preceding the actual rise of temperature.

The classical descriptions of influenza divide the cases into various types, respiratory, gastrointestinal, meningeal, septicemic, etc. The cases as they presented themselves during the cycle of 1918 were remarkable for their uniformity of type. Minor differences in symtomatology are noted in the descriptions published from different sources but there is general agreement that the respiratory type of the disease predominated greatly. It would appear that, for this pandemic at least, influenza appeared as primarily involving the respira-

tory tract and that symptoms referable to other organs were not only rare, but seemed due either to toxemia or to extension of secondary infection. Wherever a definite outbreak occurred the cases were so strikingly similar in their clinical manifestations as to leave no doubt as to their essential unity. During the severe outbreak there was a gradual change in the course of the cases, later cases running a more prolonged course with a greater tendency to the development of leucocytosis, and of secondary suppurations.

Though the clinical descriptions were in general very closely followed in the uncomplicated cases, some unusual complications were relatively frequent. These latter are considered below. One point that appears important in diagnosis is the very general agreement that the throat presented a characteristic appearance at onset. The various descriptions agree closely that the characteristic influenza throat showed a brilliantly red, glazed appearance of the pharynx and fauces without swelling or exudation. This appearance was most marked on the soft palate, and the sharp delimitation of the reddening at the margin of the hard palate was stressed. This throat condition was described not only in connection with the spring outbreak but with that of the fall as well. All patients complained of some degree of sore throat.

During severe outbreaks, many patients exhibited a hemorrhagic tendency. The frequency of this condition appears to have varied somewhat with locality. It was more common in the Army in the United States than in the American Expeditionary Forces. It was most commonly manifested by epistaxis, often recurrent, but hemorrhages from other mucous surfaces were not rare. Early and profound cyanosis of a peculiar color, described by some as "heliotrope," occurred in the more severe infections, especially in fulminant cases and in those that later developed pneumonia. Extreme prostration, out of proportion to the degree of fever or the duration of the illness, was generally recognized. So, too, was the slow return to normal in convalescence.

All degrees of severity of the primary infection were noted. At one extreme were the fulminant cases, resulting in death so promptly that secondary infection could hardly have had time to develop. At the other extreme were cases occurring in considerable numbers during an outbreak, and noted especially in the hospital personnel, in which the marked malaise and slight sore throat, with or without a little rise of temperature, were not regarded by the individual attacked as of sufficient importance to warrant relief from duty.

It has been recognized for years that the white blood count in influenza showed no hyperleucocytosis. This was confirmed during the pandemic under consideration. Extremely low counts were found at the time of greatest virulence of the infection. In the fall of 1918, almost any large series of counts showed a few as low as 2,000 or even lower. There is some evidence tending to indicate that counts lower than usual were of relatively bad prognostic significance. The following figures from Camp Custer, Mich., indicate that cases later developing pneumonia showed low counts on admission in greater proportion than did uncomplicated cases.[84]

Leucocyte counts in influenza, Camp Custer, Mich., September–October, 1918

White blood cells	Uncomplicated cases	Cases developing pneumonia	White blood cells	Uncomplicated cases	Cases developing pneumonia
	Per cent	*Per cent*		*Per cent*	*Per cent*
4,000–6,000	16.5	28.8	12,000–16,000	8.3	8.3
6,000–8,000	52.7	39.0	16,000–20,000	2.5	2.9
8,000–12,000	19.5	17.7	Over 20,000	0.5	3.3

In both series the mode falls in the 6,000–8,000 group. This coincides with the usual experience. Of all cases at Camp Jackson, S. C., 42.2 per cent had counts of less than 5,000, with an average of 6,344.[72] This included complicated as well as uncomplicated cases. The average of cases that developed pneumonia was 7,141. A report from Camp Hancock, Ga., at the time of the spring epidemic summarizes the results of 202 counts as follows:[85]

Leucocyte counts in influenza, Camp Hancock, Ga., April, 1918

Day of disease	Average count	Day of disease	Average count
1	6,166	4	8,158
2	5,378	5	8,959
3	7,522	6	7,855

The results of differential counting of the leucocytes are also concordant in the different reports. There is general agreement that the polynuclear elements are relatively reduced and the percentage of lymphocytes increased. The lymphocyte percentage during the spring epidemic often exceeded 50. In the later days of the outbreak this disproportion was not so marked, but still remained evident. Experience in the severe fall outbreak did not show so high a percentage of lymphocytes. Thus from Camp Jackson, S. C., it was reported that there was an average of 35.5 in uncomplicated cases, 27.8 in those that developed pneumonia.[72] The opinion was generally expressed that there was no relative increase of polynuclear elements unless secondary infection impended. In general the statement is almost universal that the differential count was normal or showed a relative lymphocytosis.

The clinical types of pneumonia occurring during the 1918 cycle of influenza differed so decidedly from those usually seen in interepidemic periods and even from those described for previous pandemics that some description of these cases seems necessary here. A general view of the pneumonia situation during the World War shows that there was a gradual change in the predominating clinical type of the disease from the early cases, which were in no way noticeable as different from the usual type of pneumonia, to the very atypical pneumonias of September and October, followed by a distinct tendency to revert to the types of earlier months as the epidemic declined. This change was manifested in the relative proportions of lobar and of bronchopneumonia, in changes in the proportion of cases developing secondary suppurations, notably empyema.

As stated above, prior to December, 1917, cases of pneumonia, either primary or complicating measles, were regarded by our medical officers as differing in no essential from such cases occurring previous to the World War.

Pneumonia complicating measles was not of unusually frequent occurrence. Particularly was this true as regards the earlier weeks of the great measles epidemic in the camps. However, by December, 1917, when there was a sudden increase in incidence of mild respiratory infections, variously recorded as influenza, bronchitis, coryza, etc., the number of cases of pneumonia apparently primary, as well as cases associated with measles, rose suddenly to alarming proportions especially in some of the southern camps. The pneumonia of this period was carefully studied by a special commission of medical officers working at Camp Travis, Tex.[2] They noted the presence at the time of an "epidemic of coryza, laryngitis, and mild bronchitis" in both the civil and military population of San Antonio. The report of the commission states that clinically the pneumonias studied could be divided into three groups: Bronchopneumonia, associated as a rule but not invariably with a recent measles attack; (2) lobar pneumonia, giving the familiar signs and symptoms of that disease and sometimes following measles; (3) a group showing clinically and anatomically a combination of groups 1 and 2. The description of the bronchopneumonia found there is of especial interest not only because it was the unusual feature of the outbreak, but because it is of value in comparing it with the bronchopneumonia of later waves. The cases at San Antonio were nearly all associated with the hemolytic streptococcus, though nearly half of them showed the presence of the Pfeiffer bacillus as well. Onset was gradual and without definite chill or sudden elevation of temperature, whether occurring during the course of measles or only after an interval of several weeks. The temperature rarely exceeded 104° F., and was frequently irregular even in the absence of empyema. The pulse rate was not extremely rapid even in cases near death. Respiration, too, was not extremely rapid but was characterized by extreme respiratory difficulty. Cyanosis was constant even in early cases.[a] The cough was troublesome and the sputum varied in character, though not showing the tenacious rusty type, typical of lobar pneumonia. Pain was usually marked and was associated with the frequency of pleural infection. When noted, consolidation was usually at the base. Râles, musical, squeaking, or moist, were usually heard throughout the chest. In some cases characteristic signs of consolidation in a certain area persisted for a few days and then entirely disappeared. In uncomplicated bronchopneumonia, wide areas of dullness and tubular breathing were never observed. When such signs were found there was invariably a concurrent lobar pneumonia. Empyema complicated about one-half of the cases studied and its fatality was at least 50 per cent. The lobar pneumonia studied showed the presence of pneumococci, the epidemic types being demonstrated in two-thirds of the cases. In the series showing combined lesions both pneumococci and streptococci usually were demonstrated.

During the 1918 spring epidemic, pneumonia was for the first time attributed to antecedent influenza in any considerable number of cases, although the diagnosis previously had been made. The clinical types of pneumonia seen in March and April corresponded well with those seen in the camps show-

[a] Other observers have stated that cyanosis on admission for measles characterized cases that developed pneumonia later.

ing a high death rate during the winter months. At this time the camps were much more generally affected. Empyema was still common and the mortality was generally associated with this complication. A small number of cases of a new type of the disease was seen for the first time during this outbreak. A patient with an attack of typical influenza of two or three days' duration would, after a day or two of normal temperature, develop acute pneumonic symptoms and die within 48 hours. This was the fulminant type of influenzal pneumonia familiar in the fall outbreak. The proportion of cases recorded as lobar in type was lower in the spring than in the winter and the case fatality of pneumonia was higher.[78, 79]

During the period of lower incidence of respiratory infections following the spring outbreak and lasting throughout the summer, this increased case fatality of pneumonia cases persisted and even increased as is seen in the monthly tables. The increase culminated in the month of September, 1918, with the violent outbreak of the most severe influenza wave, which first showed its great virulence in the northeastern camps.

The percentage of influenza cases developing pneumonia at this time varied in different localities. The maximum figures were about 25 per cent. The usual case fatality at this time was around 30 per cent. Though the disease, as seen in different camps, varied somewhat in its clinical manifestations due to the various factors that have been discussed, the general characteristics of the complication were very constant. Few observers were able to distinguish clinically with any definiteness in the early stages of the disease between cases which showed later lobar lesions and cases of bronchopneumonia. The following condensed description of influenzal pneumonia of the most fatal type is drawn largely from a series of studies made at the Walter Reed General Hospital, D. C.[82 86]

The onset of the pneumonic complication occurred either after two or three days of normal temperature following an attack of influenza, or it developed gradually without there being an afebrile interval. In the former group the onset was often characterized by chill and sudden rise of temperature. The severity of the disease was correlated with the amount of lung involvement, unilateral cases doing much better than those with both lungs affected. Fulminant cases with severe toxemia showed rapid involvement of the entire lung.

In nonfatal cases, usually presenting a unilateral lesion, the temperature ranged from 100° to 103° F. The pulse was characteristically slow; the blood pressure low, the systolic figure often below 100 mm.; respiration was only slightly accelerated. Nonfatal cases usually recovered after an illness of about a week and defervescence was by crisis in some series, by lysis in others. In cases with bilateral lesions the cyanosis was more marked, even to an indigo blue color, the temperature ranged somewhat higher than in the unilateral cases and often showed variations paralleling the advance and recession of the pulmonary lesion as shown by the X ray or by physical signs. Cough was frequent and exhausting; the sputum, blood tinged or mucopurulent. In the more toxic cases, terminating fatally, the color of the patient from the first was either that of an intense cyanosis or a muddy, claylike pallor. The pallor was of particularly bad prognostic import. Nervous symptoms appeared early, rest-

lessness and delirium being marked. The respiration became very rapid and dyspnea was pronounced. Physical signs of irregular consolidation and of edema filled the entire chest. The temperature ranged to 105° F. or higher, and death occurred in from three days to a week. It is evident that these groups were not clean-cut and that all degrees of varying severity intervened. Inasmuch as such a proportion of severe pneumonia has in the past seldom been associated with influenza, it is important to record in somewhat greater detail the peculiarities of this outbreak.

The first point to strike the observer was the universal occurrence of cyanosis. This condition appearing in an apparently uncomplicated case of influenza, if of a degree at all marked, usually presaged the onset of pulmonary inflammation. Whether due to toxic changes in the composition of the blood or to mechanical interference with oxygenation by the exudate in the lungs, the intensity of the cyanosis was, in general, an index to the severity of the case. In milder cases of influenza, a peculiar shade of "pink cyanosis" was observed, an erythematous flush of an unusual shade. The well-established case of pneumonia showed a shade that was usually described as heliotrope, and in the most asthenic group, usually associated with coma vigil, a muddy clay-colored pallor prevailed.

In some series of cases the tendency to hemorrhages from the mucous membranes was very notable. Epistaxis, which occurred in 10 per cent or more of the cases, was of all degrees, but often severe, recurrent, and debilitating in the extreme. Purpura, intestinal, and renal hemorrhages also occurred.

Of respiratory symptoms proper it may be said that these differed relatively little from the respiratory symptoms of the usual pneumonias. Pleuritic pain was frequent, cough was distressing, and frequently there was so much expectoration as to make resorting to narcotic relief seem dangerous. The character of the sputum varied from the tenacious rusty expectoration of typical lobar pneumonia, through varying degrees of mucopus, and frothy blood-stained material to the profuse pink froth in the mouth and nose which characterized the fulminant cases. The typical rusty sputum was rare, but the presence of some amount of blood was the rule.

From the beginning the physical signs were confusing. Typical signs of consolidation were seldom found, and then late. After some experience with these cases most observers concluded that the diagnosis of pulmonary involvement was better made from the general course and symptomatology than from physical signs. Here, too, the X-ray examination proved very valuable, as was stated above. The early signs of pneumonia were confined to the presence of fine scattered râles, and as these râles were found in many apparently uncomplicated influenza cases their significance was not clear. As the involvement proceeded, dullness became evident on percussion, and breath sounds, voice, and fremitus were diminished, thus suggesting fluid in the pleura. Areas of tympany were also observed. After several days the confluence, or extension of consolidated areas, often produced typical signs of consolidation. Pleuritic friction was often heard.

The heart action was slow in proportion to the temperature, and right-sided dilatation was not the rule even in severe and fatal cases. Low blood

pressure was noted, in some cases the systolic blood pressure falling as low as 80 mm. without a necessarily fatal issue. The temperature was very variable, usually of a fairly continous type, but in some cases remissions with sweating were frequent even without suppurative complications. The leucocyte counts were also variable, some fatal cases showing no change from the initial leucopenia. In others a marked polynucleosis supervened. Pneumococcus cases showed this rise earlier than did cases infected with streptococci. Blood cultures were positive in a relatively small proportion of cases, and pneumococcus infection gave the great majority of the positive results.

Toxic nephritis, varying in degree, occurred in nearly every case. The presence of large numbers of casts was almost invariably of fatal import. Gastro-intestinal symptoms were rare, though early and persistent vomiting occurred in the highly toxic cases. Constipation was the rule. Toxic involvement of the nervous system was evident in all the more severe cases. There was sleeplessness, restlessness, severe headache and, to a greater or lesser degree, delirium. The delirium appeared to be related to the degree of toxemia rather than to the temperature. Two types of delirium were noted: A restless talkative type, hard to control, but unassociated with a lack of orientation when the patient was questioned; the coma vigil type. The talkative type was not of very bad prognostic import, but almost all cases who had the coma vigil type of delirium died.

Skin eruptions were prominent in some series of cases and hardly mentioned in others. At the Walter Reed General Hospital a reddish eruption of a maculopapular character, occurring typically on the chest and back, was seen in about two-thirds of the cases. It differed from acne in the absence of pustules, and from sudamina in the absence of vesicles. It persisted into convalescence and was followed by scaling. Profuse sweats occurred in the highly toxic and in convalescents.

The case fatality of the pneumonias of this outbreak varied from 19 per cent in some of the southern camps to 51 per cent at Camp Sherman, Ohio. Certain camps in the same State and having apparently the same class of troops showed variation in this respect, thus suggesting that different standards were adopted in the diagnosis of pneumonia. From the account of symptoms and physical signs given above it is easily seen how this could have happened. During the fall wave the greatest percentage of total strength dying as a result of the epidemic was 3.3 (Camp Sherman, Ohio, and Camp Cody, N. Mex.). From this figure it ranged down to less than 0.5 per cent.

COMPLICATIONS AND SEQUELÆ

Aside from the pneumonias which have been considered above, there was a notable absence of complications of influenza. Of 734,397 cases admitted with a primary diagnosis of influenza from our troops in the United States and in Europe, the following secondary diagnoses were recorded.[1]

Epidemic cerebrospinal meningitis	542
Acute articular rheumatism	396
Pulmonary tuberculosis	956
Acute miliary tuberculosis	21
Arthritis	916
Hyperthyroidism	143
Neurocirculatory asthenia	465
Neuralgia	89
Neuritis	143
Psychasthenia	14
Psychoneurosis	114
Psychosis, manic-depressive	25
Conjunctivitis	299
Amaurosis	2
Iritis	31
Otitis media	3, 431
Laryngitis (acute catarrhal)	490
Acute tonsillitis	2, 617
Acute pharyngitis	678
Mastoiditis	423
Otitis externa	48
Sinusitis (all)	1, 023
Pericarditis	139
Acute endocarditis	50
Cardiac dilatation	109
Myocarditis and myocardial insufficiency	330
Phlebitis	225
Bronchitis	5, 081
Bronchopneumonia	52, 463
Lobar pneumonia	21, 742
Empyema	2, 129
Serofibrinous pleuritis	904
Pulmonary emphysema	61
Asthma	229
Ulcer of the stomach	22
Ulcer of the duodenum	15
Diarrhea	366
Enterocolitis	553
Hernia	516
Anal fistula	30
Cholecystitis	80
Peritonitis	46
Acute nephritis	313
Pyelitis	41
Cystitis	69
Epididymitis (nonvenereal)	163
Abscess, subcutaneous	370
Furuncle	205
Cellulitis	164
Erythema	44
Herpes	60

Though it is undoubtedly true that, in the press of work occasioned by the epidemic, many minor complications were not recorded, the above figures probably represent with some accuracy the incidence of complications and sequelæ important enough to have an effect on the clinical course of the case. It is seen that, with the exception of the respiratory complications, the number recorded under any heading is very small in proportion to the total number of admissions.

A number of reports on the incidence of otolaryngological complications have been published. Reports of the symptomatology of the disease indicate that catarrhal otitis media without perforation was of frequent occurrence, though exact figures are not available. The figures in the above tabulation probably represent fairly accurately those cases of otitis that required special attention or operation. It is seen in the tabulation that this complication occurred in 3,431 cases out of 734,397, or only 4.68 instances per 1,000 influenza admissions. The rate of secondary otitis media for all medical cases, exclusive of influenza, is 5.01 per 1,000. Measles had a rate of 41.9 per 1,000, scarlet fever 35.2, and epidemic meningitis 21.6. There is no doubt that there is some slight tendency toward lowered resistance in parts other than the lungs during the course of influenza, but were the statistics available it is certain that it would appear that the vast majority of these infections were associated with influenzal pneumonias of corresponding bacterial origin rather than with the primary disease itself.

In general, complications were less frequent proportionately during the height of the fall outbreak than was the case during the earlier waves and during the period of decline after the fall wave. This is particularly true of the incidence of empyema.[a] Several complications, while not numerically important, are of great interest on account of the fact that they appear to have attracted particular attention for the first time during this pandemic.

The first of these is subcutaneous emphysema.[87] In this condition the subcutaneous areolar tissue becomes infiltrated with air over a greater or lesser extent of the body. It usually began above the clavicles or manubrium and extended in some instances until practically the entire body was affected. Its occurrence was extremely irregular, some large series of cases being reported without noting it and others reporting several cases in a comparatively small number of admissions. Camp Hospital No. 12, A. E. F., reported 13 cases, of which 5 occurred in the same ward and the first 3 in adjoining beds. This distribution led to the consideration of an infective origin for the complication and from 4 of the cases an anaerobic spore-bearing gas former was isolated. However, the great majority of cases failed in other hands to show any such origin, and the generally accepted theory of the pathogenesis of the emphysema, based on careful autopsy studies, is that it is the result of rupture of the dilated bronchioles, the air passing along the vessel sheaths to the mediastinum and thence to the subcutaneous tissue. The slow dissection thus accomplished by the air is remarkably painless; and while its occurrence is prognostically bad, by no means all of the extensive cases were fatal.

Another interesting complication is the degeneration of the rectus muscle, usually accompanied by rupture and hemorrhage. After attention was called to this occurrence a few instances were reported in almost every autopsy series. McCallum[79] noted it in the 1918 spring epidemic. The primary lesion appears to be a hyaline degeneration of the muscle fibers with loss of striation, similar to if not identical with the condition known as Zenker's degeneration. When rupture and hemorrhage are added, bacterial invasion of the area may result in the formation of abscess. This condition doubtless accounts for many of the instances of abdominal pain and rigidity, simulating peritonitis, that were observed during the epidemic.

Inflammation of the accessory sinuses of the nose, while rarely giving rise to clinical symptoms, was almost invariably found post-mortem. The post-orbital headache of the early days of the disease has been attributed to sphenoidal sinusitis. There has been a fairly prevalent belief that influenza was frequently followed by pulmonary tuberculosis. It is seen from the tabulation given above that in 956 instances the diagnosis of tuberculosis, secondary to influenza, was recorded. This amounts to 1.3 instances per 1,000 admissions. In all noninfluenzal admissions this diagnosis was recorded secondarily in 1.5 of every 1,000. These figures should perhaps be accepted with caution owing to the fact that the great majority of the men affected by influenza were discharged from the service within a few months time and late-developing tuberculosis might have been missed. However, the mortality statistics of the registration area for the years following 1918 have shown a progressive decrease in the death

[a] Empyema is given separate consideration in Pt. II, Vol. XI, of this history.

rate from tuberculosis in civil life. It seems very improbable that any great number of cases of tuberculosis owe their origin to the influenza epidemic. The same general conditions hold for neurocirculatory asthenia. Here, again, although 465 cases are recorded as following influenza, the rate per 1,000 is lower than that for cases that were not influenzal.

TREATMENT

In the absence of definite knowledge of the etiology of influenza, no specific remedies are available for its cure. The current conception of this disease as a relatively mild respiratory infection, short in duration and leading to fatal results only when complicated by secondary infections, usually pulmonary, results in a treatment logically directed to shorten its course, to limit the amount or degree of primary pulmonary damage, to protect the patient against secondary infection from his fellows, and to reduce if possible by these means the proportion of fatal pulmonary complications. Further treatment aiming to promote the comfort of the patient is the second line of attack. When pneumonia has developed there are several methods of treatment in influenzal cases that do not apply in interepidemic periods, but in general the disease is best treated along orthodox lines.

INFLUENZA

Since the main aim of treatment in the uncomplicated early influenza case is the avoidance of pulmonary complications, the results of treatment are best estimated by consideration of the percentage of recoveries without pneumonia. The principles of treatment best adapted to this end have been well established, although definite statistical evidence of the same can not be given here owing to the fact that other factors predominated in determining the severity of cases as occurring in different localities. These factors have been included in the consideration of the epidemiology and of the prevention of the disease (vide supra).

Experience, however, led to the crystallization of the general opinion that certain measures resulted in reducing the proportion of pneumonia cases. Of these the first and perhaps most important was the early institution of treatment. Men who continued on duty after definite symptoms had developed were much more likely to develop pneumonia. The excellent morale of the combatant troops in the face of the enemy, which led many soldiers to refuse to report themselves sick until forced to do so, is believed to be one great cause of the greater proportion of pneumonias and relatively high fatality shown by the troops in the American Expeditionary Forces.[88] The important elements of treatment, once the patient comes under medical care, were found to be rest in bed, warmth, and a light, hot diet. It is the consensus of opinion that under such treatment the great majority of cases are convalescent within two to three days. The question of open-air treatment has been much debated, but the weight of opinion is to the effect that open-air treatment is only permissible when it may be maintained without sacrificing the warmth of the patient. Drug treatment is of a palliative character. Aspirin was largely used for the pains of onset, though it was criticized by some as being depressant. Dover's powder, or morphine, to promote rest; sprays, preferably oily, to relieve naso-

pharyngeal discomfort, and laxatives as needed comprise most of the drugs used. One report is available of the use of serum from convalescents in early cases. This showed that of 26 cases so treated only one-third the proportion of pneumonias resulted as in the untreated series and the average duration of fever was over 50 per cent longer in the controls.[83]

PNEUMONIA

The general principles applicable to the uncomplicated influenza cases in regard to rest, warmth, and ventilation apply equally here. The usual drug medication was generally used without striking success. Specific treatment with antipneumococcus serum in type I cases was generally used and showed generally satisfactory results.[89] Other attempts at specific treatment directed against the pneumococcus included the use of polyvalent antipneumococcus sera, the use of the Kye's antipneumococcus chicken serum, the autolyzed pneumococcus antigen of Rosenow, and the therapeutic use of bacterial vaccines.[90] Favorable reports on all these measures have been made by those who used them, as was also the case with the use of the serum or citrated blood of convalescents. It is to be noted that all except the last of these measures involves the introduction into the circulation, usually intravenously, of protein products foreign to the human system. This is also true of the type I serum, the effects of which, however, are so much more clean-cut than those of the others that its specific action may hardly be questioned. These considerations have led many to the belief that a nonspecific protein reaction is of benefit and some have aimed in their treatment to obtain a sharp reaction. To quote a report from Camp Greene, N. C.:[91]

> It was the impression of some observers that not a few cases reported as other than type I showed benefit from the serum treatment. It was also the prevalent belief that in cases in which a chill follows the administration there was increased likelihood that 12 hours later the temperature would be much lower and the general condition improved.

Reports of the intravenous use of bacterial vaccines in doses sufficient to induce sharp reactions, repeated daily, show definitely good results.[92] It appears to be quite definitely proven that such induced reactions do good. No harmful effects have been reported, and the claim is that the temporary discomfort of the chill is followed by a feeling of comfort and well being very grateful to the patient.[70] [93]

The intravenous use of hypertonic glucose solutions, while lacking the protein element, also results in a similar type of reaction in a certain proportion of cases. The advocates of this method of treatment, after extensive trials, claim that its use promotes comfort, produces rest and sleep, reduces temperature, increases elimination through kidneys and skin, slows the heart, and increases the volume of the pulse. It also supplies nutriment in a readily assimilable form and furnishes an excellent vehicle for the administration of specific sera, digitalis, morphine, or other medication. Comparisons showing reduction of mortality under strictly controlled conditions as a result of this treatment are not to be had. The method was used most extensively at Camp Travis and Fort Sam Houston, Tex., situated in the region where relatively low fatality prevailed. It has already been noted, however, that the case

fatality there was appreciably lower than in neighboring camps under apparently the same climatic conditions and made up of the same type of men. The solution, from 5 to 25 per cent in strength, was given in amounts of 250 c. c. intravenously once or twice daily.

Notes were made of marked improvement following several cases of lung puncture for diagnostic purposes. The induction of artificial pneumothorax resulted in recovery in two cases apparently moribund.[82] The suggestion was made on the ground of autopsy findings that aspiration of the chest should be performed early when signs of pleural fluid were noticed.[94] Venesection was used to some extent in the severe cases of hemorrhagic edema of the early stages of the 1918 fall outbreak. The excellent results obtained by this means in gas pneumonias, together with the similarity of the pathology in the two conditions, lead to the expectation of marked benefit.[95] There is decided difference of opinion as a result of experience. Some have reported marked benefit, while others state that no results were obtained.

In general it may be said that the experience of the World War has confirmed the position of the antipneumococcus serum, type I, when given in sufficiently high titre and proper dosage; it has led to a widespread belief in the beneficial effect of nonspecific protein reactions however induced and an equal belief in their essential harmlessness; it has shown the beneficial effect of the intravenous use of hypertonic glucose solutions, although experience with this agent was not general; and, lastly, owing to the universal agreement of the many who made use of convalescent serum in some form as to the good effect of this treatment, it appears established that the serum of convalescents contains curative antibodies.[96] This last observation encourages the hope that with the discovery or recognition of the primary etiological agent of influenza a hyperimmune serum may be developed in animals which may at least prove effective in limiting the amount of pulmonary damage done by the primary disease and thus prevent the pneumonic complications.

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CHAPTER III

TUBERCULOSIS [a]

ORGANIZATION FOR ELIMINATING THE TUBERCULOUS FROM THE ARMY

Soon after the United States entered into the war against Germany it was decided by the Surgeon General that the United States Army should be reexamined for tuberculosis by the best available experts.[1] The chief reason for this decision was the obvious importance, in view of the difficulties of transportation, of allowing no soldiers to be sent abroad who were doomed in advance to an early breakdown. The fact, however, had been alleged and had been given wide publicity, that the French Army had suffered severe losses from tuberculosis [2] and, as it was generally admitted that that disease was rife among the French civil population, the fear that our Army would suffer in the same way as the French Army was felt by many of the medical profession and of the laity. Whether or not this fear was well founded, it would evidently be advantageous, as a matter of policy, to give the public to understand that every possible precaution would be taken to safeguard our Army against tuberculosis, and this consideration was no doubt of weight in the mind of the Surgeon General. The supervision of the accomplishment of these measures was to be the function of the division of internal medicine, Surgeon General's Office. This division was established in the summer of 1917, the tuberculosis section of that division entering upon its task on June 6, 1917.[3]

The first question to be decided was the manner in which the expert examinations should be made. The advice given by a committee of prominent members of the National Association for the Study and Prevention of Tuberculosis[b] in its report to the medical committee of the advisory board of the Council of National Defense, was that the experts should act as consultants, examining such cases as the medical officers of the Army might refer to them.[4] This method presupposed painstaking and efficient examinations by examiners competent to detect the cases suspicious of tuberculosis. It afforded no guaranty that persons with manifest tuberculosis would not be admitted into the Army as the result of hurried or otherwise imperfect examination. Under the circumstances, however, in which our Army was hastily collected, it was to be expected that cases of tuberculosis would be overlooked. To overcome this it was necessary that every man should be reexamined, and, moreover, the examining should be done promptly in order that the claim might not be made with success that such chronic lung affections as were discovered were the result of military service thus permitting the pensioning of the individuals concerned. Therefore, it was at once decided that the examiners should pass upon the lungs of every man who had been admitted to the military service, notwithstanding the staggering magnitude of the total of examinations for which this decision called.

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[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—Ed.

[b] The members of this committee were Dr. Herman Biggs, Dr. G. M. Kober, and Dr. Charles J. Hatfield.

Medical officers of the Regular Army who were qualified for this work were already engaged with even more important duties, chiefly of an administrative character, and could not be spared; while the Medical Reserve officers already commissioned who were competent internists had been assigned to medical organizations from which they could not be withdrawn, as a rule, without impairment of the efficiency of these organizations. It was necessary, therefore, to resort to civilian physicians, and the plan was adopted of calling upon prominent experts in internal medicine in each of the largest medical centers to recommend candidates for this work.[5]

A difficulty was experienced at the outset because the duty of the examiner was to be in the United States, and most ambitious and active men desired service abroad. It was soon seen that the examiners must be chiefly recruited from the class who were physically unfit for the arduous field service. But with this class the difficulty at once arose that the men especially interested in tuberculosis work had themselves had the disease, a fact which under ordinary conditions would debar them from admission into the Army. It became necessary to waive this fact for duty in the United States solely in connection with tuberculosis work and to accept applicants otherwise fitted for the duty contemplated for them whose physical condition warranted service of this kind.[6] This course met with objections on the part of the officer in charge of the personnel division, Surgeon General's Office, who apprehended that it would be advanced as a precedent by the numerous physicians who besought the War Department for commissions in spite of physical defects. These objections were met by the argument that the tuberculosis examiners being a special and limited class, to be used for a specific purpose, their cases were not analogous to those of men with disabilities who sought general service as medical officers and should therefore be capable of enduring hardship in the field. These various difficulties created an enormous correspondence. At one time it seemed as if the plan must fail because examiners in sufficient numbers were not to be found. However, slowly, much too slowly, a corps of examiners was commissioned and set at work, the effort being to reach first the newly appointed officers and the troops about to sail for Europe.

Examinations did not begin until July, 1917. By an unnumbered circular of the War Department, dated July 16, 1917, it was provided that the examiners for tuberculosis should be organized into boards.[7] The size of the individual boards was governed by the size of the command examined, but no board was to consist of less than three examiners. From the examiners, disability boards were appointed in order that the necessary steps for discharge might be taken at once and without the need of referring the cases elsewhere and thus requireing a repetition of the examinations.

Decision as to the physical signs which should determine rejection on account of pulmonary tuberculosis depends naturally upon our conception of the nature of the tuberculous processes as they affect the lungs. If erroneous ideas lead to the unnecessary rejection of many thousands of men, such errors may have disastrous results in the conduct of military operations. The view was formerly held by all, and is still much too widely spread, that the population is divided as regards tuberculosis into a healthy majority and a tuberculous

minority and that tuberculosis is infectious for adults, at least for those who are not already labeled tuberculous. It is even believed by some that active forms of tuberculous disease may be made worse by contact with other cases, if this leads to exposure to large amounts of tuberculous virus, or if the tubercle bacilli in these latter cases are of a more virulent type. The elimination of the tuberculous from the Army in this view would be urgently required for the protection of their healthy comrades.

What may be called the modern view is based upon the well-established fact that practically every civilized adult has come into contact with the tubercle bacillus and has thereby acquired what in a sense is a tuberculous infection. But in the large majority of the population this tuberculous infection remains latent throughout life and amounts to a vaccination against tuberculosis. And in those less successfully protected against tuberculosis the form of the disease which declares itself is chronic and often relatively benign, differing materially from the form of tuberculosis met in young children and others who have had no previous contact with the disease before acquiring an infection with massive dosage. An individual already infected with tuberculosis can be reinfected from without, if at all, only by large amounts of tuberculosis virus. If thus capable of exogenous infection he is likewise subject to endogenous reinfection, or will be unable to prevent the extention of already existing, but perhaps latent, tuberculous processes within his body. Exogenous infection in civilized man is not, therefore, of importance; nevertheless, on account chiefly of unprotected children, every care should be taken to destroy the poisons of tuberculosis.

Circular No. 20, Surgeon General's Office, was published on June 13, 1917, for the guidance of medical officers in connection with examinations for pulmonary tuberculosis, after having received the approval of eminent clinicians. This circular indicated the duties of medical officers, called attention to physical signs of the chest often erroneously considered as signs of disease, and defined the signs of tuberculosis which should lead to rejection, including within its scope the interpretation of X-ray findings. Because of its comprehensive character it is quoted here in full:

CIRCULAR No. 20.

WAR DEPARTMENT,
OFFICE OF THE SURGEON GENERAL,
Washington, June 13, 1917.

The following is published for the information of medical officers for use in connection with examinations for pulmonary tuberculosis in the military service.

The duties of the examiner are:

1. To exclude cases of manifest tuberculosis from the Army.

2. To hold to service men who allege tuberculosis as a ground for exemption or discharge on the basis of insufficient or incorrectly interpreted signs and symptoms.

3. To determine in the case of soldiers accepted for the military service the existence of pulmonary tuberculosis, and to decide whether or not the disease has been incurred in the line of duty.

Men who desire to serve their country may conceal, from patriotic motives, symptoms of tuberculosis which they know or suspect to exist. Some tuberculous patients will seek enlistment with a view to obtaining treatment and a pension. Some soldiers who have volunteered may repent their action and allege symptoms of tuberculosis with a view to securing discharge. Some conscripts may be expected to claim the existence of tuberculosis

as a ground for exemption, and may fortify their claims by certificates of physicians and by radiographs. There will probably be many cases in which pulmonary tuberculosis will have been diagnosticated on the ground of subjective symptoms and of physical signs which are normal or indicate unimportant and healed lesions of some kind.

It is necessary therefore that conclusions of the examiner shall be based only on physical signs, sputum examinations, and radiographs. Statements of the subject as to symptoms will not be accepted as proof of the existence of tuberculosis unless supported by objective evidence.

It is the duty of examiners to protect the interests of the Government by preventing men from entering the service who have manifest tuberculosis. It is equally their duty to prevent the escape from service on the ground of tuberculosis of men who present slight or doubtful deviations from the normal. It is therefore necessary to insist that recommendations for discharge for tuberculosis of otherwise apparently healthy and vigorous men shall be based only upon the presence of definite and plainly marked signs of pulmonary lesions.

The following signs will not be regarded as evidence of pulmonary disease in the absence of other signs in the same portion of the lungs:

1. Slightly harsh breathing, slightly prolonged expiration over the right apex above the clavicle anteriorly and to the third dorsal vertebra posteriorly. The same signs at the extreme apex left side.
2. Same signs second interspace right anteriorly near sternum (proximity of right main bronchus).
3. Increased vocal resonance, slightly harsh breathing immediately below center of left clavicle.
4. Fine crepitations over sternum are heard when stethoscope touches the edge of that bone.
5. Clicks heard during strong respiration or after cough in the vicinity of the sternocostal articulations.
6. The so-called atelectatic râles heard at the apex during the first inspiration which follows a deeper breath than usual or a cough.
7. Sounds resembling râles at base of lung (marginal sounds), especially marked in right axilla, limited to inspiration.
8. Similar sounds heard at apex of heart on cough (lingula).
9. Slightly prolonged expiration at left base posteriorly.
10. Very slight harshness of respiratory sounds with prolonged expiration in the lower paravertebral regions of both lungs posteriorly, most marked at about angle of scapula, disappearing a short distance above that point, equal on both sides, or slightly more marked at the angle on one side, more frequently the left.

THE APICES

Incipient tuberculosis of the apex is often erroneously diagnosticated:

1. On account of misinterpretation of normal signs.
2. Because the importance of minor differences between the two sides is exaggerated.
3. Because signs of a healed lesion are considered to indicate an incipient lesion.

For No. 1, see No. 1, page 2.

With regard to No. 2, it is not too much to say that, given a sufficiently minute examination, there would be few men who would fail to show some signs which might be interpreted as having pathological significance.

No. 3. The truly incipient tuberculosis of the apex generally escapes detection when in an active state. When healed it constitutes the abortive tuberculosis of Bard. Induration of the apex has been described by Krönig as a nontuberculous affection. The important question here is whether the signs present indicate a healed or active process. They are harshness of respiratory sounds, prolongation of expiration, increased conduction of voice, and more or less dullness on percussion. These signs are caused by induration of pulmonary tissue. Induration caused by acute inflammation is relatively rare in tuberculosis. It is not characteristic of a recent but of an advanced process, when present to an extent which permits detection by clinical methods. When it does occur, the subject is usually febrile

and evidently ill. In cases of ambulant subjects in apparently good health the presumption is that the above signs indicate an old, not an incipient lesion. The abortive tuberculosis of Bard and Krönig's apical induration, whether or not it is due to an obsolete tuberculosis, are not causes for rejection in the absence of tuberculous disease at a lower level in the upper lobe. Narrowing of Krönig's isthmus is extremely common. It is not a sign of recent disease but of contraction of the lung from old disease. In consideration of the frequent asymmetry of the bony structures about the apices slight differences in the width of the isthmus on the two sides are unimportant. A distinct contraction of one side points to the existence of a tuberculous focus of the upper lobe; whether or not this focus is of clinical importance must be determined from the signs in the individual case. Contraction of the isthmus *per se* is not a cause for rejection. The attention of examiners is particularly invited to the necessity of exercising great conservatism in their interpretation of physical signs over the apices. Interpretation of such signs as indicating active tuberculosis would in many cases do the Government great injustice, leading to the exclusion of men who are fit for service. The only trustworthy sign of activity of apical tuberculosis is the presence of persistent moist râles.

Diagnosis of Tuberculous Lesions in General

THE ACUTE LESION

If small lesion is manifested by râles with or without changes in breath sounds, percussion note, and voice transmission. The more acute the lesion the greater the probability that its presence will be indicated only by râles. If of large extent the process is distinctly a broncho-pneumonia, generally caseous, characterized at first by the usual signs of pneumonia, crepitant, and subcrepitant râles; when caseated by absence of râles, except coarse and distant râles from the larger bronchi, also by impairment of expansibility of the lung, and more or less dullness or tympanitic resonance; when breaking down by cavity signs and the presence of loud moist râles of varying size. Large acute lesions are rarely found in candidates for enlistment and the small acute lesion is also comparatively rare. Tuberculosis as it presents itself to the Army examiner is usually of a chronic type.

THE ARRESTED CHRONIC LESION

It is by no means rarely the case that a tuberculous lesion will run its course and become arrested without the knowledge of the subject, who may state in perfectly good faith that he has never had tuberculosis. The arrest of a lesion is indicated by the absence of râles. Such a lesion is characterized by harshness of breath sounds and prolongation of expiration, by increased vocal fremitus and resonance and by more or less pronounced dullness on percussion.

THE ACTIVE CHRONIC LOCALIZED LESION

Activity is denoted by the presence of râles, together with the other signs described under the arrested lesion. Râles do not necessarily show that the lesion is extending nor that the activity is of much clinical importance, but in military practice the presence of râles accompanied by breath changes and other signs should be an indication for rejection. The more active and recent the chronic lesion the less marked the breath changes and the more conspicuous the râles.

DISSEMINATED TUBERCULOSIS

True miliary tuberculosis is not likely to come to the attention of the military examiner. The peribronchial type is common and frequently not recognized. In the adolescent the peribronchial tuberculosis may be extending from the deep lung without as yet developing a superficial focus. It may be manifested only by the presence of distant râles with or without slight changes in the breath sounds which are of a slight bronchovesicular quality. If the case is well marked there will be impairment of expansibility of the affected side and increased vocal resonance. Less pronounced cases are distinguished from chronic bronchitis only by the character of the râles (coarser in bronchitis) and by their topical distribution.

More frequently the peribronchial type is found accompanying a superficial focus. Bronchovesicular breathing may extend some distance below the limits of the superficial focus with or without râles. But the most important manifestation of the peribronchial type is extension to the formerly sound side. There may be a small, obscure, apparently arrested lesion of one side, usually the right, with a peribronchial extension involving the whole or the greater part of the other lung manifested only by the presence of râles after expiration and cough.

A definitely demonstrated tuberculous lesion of more than insignificant size below the apex is cause for rejection whether such lesion be active or inactive. But men whose qualifications make their service of especial value to the Government should not be rejected without previous report of their cases to higher authority if the lesion found is not very large and is entirely quiescent. In case of the acceptance of a man with tuberculosis a careful record of the case should be made for the protection of the Government. Such cases should be frequently reexamined.

In ambulant afebrile subjects harshness of breath sounds and prolongation of expiration characterize the old and relatively dry lesion, while the more acute the process the less marked are the breath changes and the greater are the conspicuousness and significance of râles. No examination for tuberculosis is complete without auscultation following a cough.

THE METHOD OF "EXPIRATION AND COUGH"

It is best executed as follows: Starting from the state of rest of the lung the subject forcibly expels the air from the lungs, reserving the last portion of the expiration for a short cough, after which inspiration immediately follows, but only enough air is inhaled to return the lung to the state of rest. The idea is to diminish the size of the bronchi as much as may be by expiration, then to cough to stir up forcibly such fluid as may be present in them. The moisture is more likely to be moved by the current of air and so produce râles when the tubes are of their least caliber. This procedure should invariably be employed in examinations in order to determine the activity of lesions found by other signs and also to detect the existence of fresh disseminated tuberculosis.

EXAMINATION OF SPUTUM

The presence of tubercle bacilli in the sputum is a cause for rejection. Examiners should, however, take pains to convince themselves that the sputum examined came from the lungs of the person under examination. To this end they should insist that the sputum be coughed up in their presence or in that of the pathologist who makes the microscopical examination.

TUBERCULIN

It is well recognized that a positive reaction to tuberculin, especially in the young adult, is not a proof of the presence of active clinically important tuberculosis. Tuberculin only demonstrates activity of the tuberculous process in the clinical sense when it can be shown to produce a focal reaction. Such reaction is not without danger. Since, therefore, tuberculin rarely leads to a correct diagnosis and may do injury, its general use in the diagnosis of tuberculosis in examinations for enlistment is prohibited

X RAY

Only well-marked pathological changes are revealed by radioscopy. For the accurate diagnosis of tuberculosis recourse should always be had to the study of the X-ray negative. It is not of course practicable to use radiography extensively for the determination of tuberculosis during the examination of recruits. But the X ray will doubtless be often employed in doubtful or disputed cases, so that it is necessary to consider the rules which should obtain in reading the radiograph.

Morbid changes in the lungs are shown by shadows due to two substances: First, blood; second, fully organized connective tissue. Blood imprints a shadow on the negative only when present in abundance. The congestion of lobar pneumonia is typical. Bronchopneumonia of tuberculosis origin may also cast shadows, but only when the process is acute,

the congestion great. Frequently the tuberculous process runs so chronic a course that the inflammatory reaction is insufficient to congest the lung enough to produce a shadow. The shadow of congestion is not sharply outlined; it melts away at its borders.

Connective tissue in the parenchyma of the lung away from the hilus is not normally present in sufficient quantity to retard appreciably the passage of the X rays except as it occurs in connection with and as a part of the various tubes, bronchi, blood vessels, and lymphatics. As a result of proliferative inflammation connective tissue develops as a fibrous thickening of these tubes, particularly the bronchi and the lymph vessels which casts a shadow deeper than normal; the older the process and the better organized the tissue, the denser the shadow and the sharper its outline. Tubercle, caseations as such, cast no shadows distinguishable from the other tissues of the parenchyma. It has been found that cubes, 1 c. c. in size, of caseous tubercle when embedded in a healthy lung are indistinguishable by the X ray. But if the caseations become calcified or are even impregnated abundantly with mineral salts they become opaque to the X ray. In general, and especially if one has to do with the shadows of tubes, it may be said that fuzziness of outline means acute vascular congestion, an active process. On the other hand, when the shadows of the tubes are sharp we have a process which, if active at all, is at least not characterized by great acuity, is not congestive. There is what is called dry tuberculosis of the lung tissue, which inclines to abundant formation of connective tissue, to dry caseations and cicatrizations or to complete transformation into fibrous tissue, characterized by sharply outlined granular spots and by more or less sharply marked bands and streaks. Special attention is called to the persistence of the sharply outlined dots and lines when activity of the tuberculous process no longer exists. The sharply outlined thickenings of the bronchi and other tubes may be evidence of an old inflammation now entirely obsolete, may be simply records of the ancient history of the pulmonary tuberculosis.

We do not see tubercles in the X-ray negatives. What we see is either sharply outlined calcifications and fibroses, or fuzzy congestions, or a combination of the two conditions. Cases are seen in which the X ray in general gives the same findings in both lungs while the autopsy proves one lung severely, the other slightly, diseased. Such cases illustrate well the limitations of X-ray diagnosis. What is seen in the X-ray negative is the thickened framework of old inflammation in the two lungs, in one accompanied by much parenchymatous disease of recent origin, in the other accompanied by little, the said parenchymatous disease being invisible to the X ray because neither sufficiently congested nor sufficiently organized to cast shadows.

Extensive systems of lines, many sharply outlined spots, dense streaks do not, then, show an acute process. Persons in good health with nearly or quite arrested tuberculosis are sometimes found by the X ray to present a picture of very extensive changes of this kind. Yet the prognosis in such cases is not good if the subjects be subjected to severe strain. The radiograph is a proof that the lungs have undergone serious changes. The danger is either that hardship will lead to a reactivation of the numerous more or less quiescent tuberculous lesions or, if the process has been largely of the nature of fibrosis, that the lungs have been so damaged thereby as to unfit the person for an active life. If then the radiograph shows extensive dappled or mossy shadows or numerous spots and streaks the recruit should be rejected however good his health may appear to be. Shadows of a homogeneous opacity result from pleurisy and are not necessarily a cause for rejection in the absence of other signs.

Tuberculosis of the bronchial glands is a diagnosis often made from the radiograph on very slight foundation. The fact is that pronounced swelling of the lymph glands is characteristic of primary, not of advanced tuberculosis. It is rare that intrathoracic gland tuberculosis is of any clinical importance in the adult. With few exceptions cases of bronchial gland tuberculosis which lead to true symptoms of disease are confined to the first and second years of life. Only rarely, especially in adults, is so-called hilus gland tuberculosis a purely glandular process; it is rather a more or less pronounced disease of the surrounding hilus tissue in the form of peribronchial and infiltrative processes of the neighboring pulmonary tissues. That is, the interscapular dullness relied upon for the diagnosis of enlarged glands, if caused by lung conditions, is due to tuberculous processes in the region of the hilus, partici-

pation in which to any important extent on the part of the glands is a matter of conjecture. The presence of masses in the neighborhood of the hilus as shown by the X ray may indeed be cause for rejection, but rejection on account of relatively small opacities in that region on the ground that they indicate a bronchial gland tuberculosis of clinical importance certainly should not be permitted.

RÉSUMÉ OF INDICATIONS FROM X-RAY NEGATIVES

The X ray shows—1. Tuberculous disease confined to region of hilus in deep lung. 2. Extension upward toward apex or downward and outward toward base, confined to deep lung. 3. A fine line or two extending to apex with or without small focus or foci there—condition not determinable by physical signs. 4. Clouding of apex without marked lines from hilus, probably largely pleuritic. 5. Well-marked lines extending to superficies of apex usually, but not necessarily, with foci there—lesion accessible to physical examination. 6. Lines extending toward shoulder as well as apex. (*a*) If confined to deep lung may mean early and now obsolete exacerbation. (*b*) If extending to superficies denote larger lesion and less immunity than 5. 7. More or less widely diffused spots, lines, and streaks through a considerable portion of lower lobe approaching periphery of lung, with few or no auscultatory signs—deep peribronchial tuberculosis. 8. More extensive streaked opacities involving greater part of one or both lungs and extending to periphery with few or many physical signs—fibrocaseous tuberculosis, fibrosis preponderating in proportion to scantiness of more or less rounded spots or dots.

Conditions as shown by 1, 2, 3, 4, and 6 (*a*) are not causes for rejection. Cases under 5 are to be determined by physical examination. Cases under 6 (*b*), 7, and 8 are to be rejected.

W. C. Gorgas,
Surgeon General United States Army.

Approved, by order of the Secretary of War, June 16, 1917. (2621428, A. G. O.)

The boards first at work were constituted by the specialists of Colorado, who had been prompt in their response, and were engaged in the examination of troops of the Regular Army at that time stationed in the Rocky Mountain region. While these examinations were proceeding in the West, in the East men at the officers' training camps were first examined. Of 53,905 examined, tuberculosis was discovered in 195, or 0.362 per cent. In the aviation service 38,835 men furnished 62 cases of pulmonary tuberculosis, or 0.159 per cent. Combining these figures we have a total of 92,740, with 257 rejections; a percentage of 0.277.[8] Both of these groups consisted, in a sense, of picked men, many of them athletes. The scanty result obtained, which scarcely justified the reexaminations, shows that a sufficiently rigid selection of promising material in itself practically excludes tuberculosis.

In the Regular Army in the field 190,396 men were examined, with the rejection of 1,444 cases of tuberculosis, or 0.758 per cent. Examination of 40,396 men of the Coast Artillery Corps discovered 297 cases of tuberculosis, or 0.735 per cent.[9]

The National Guard was mustered in on August 5, 1917.[9] Since not all of the camps, which were in preparation for them, were ready for use in September, many of the National Guard organizations were left at home for several weeks subject to call at their armories.[10] On account of the scarcity of commissioned tuberculosis examiners, the expedient was adopted of employing temporarily, as examiners, physicians from the vicinity of the regimental headquarters, who were given contracts to examine some of these organizations in their armories. Reports show a total of 446,517 men of the National Guard

examined, of whom 1.099 per cent were found to be tuberculous. Of these examinations, 69,273 men were examined at armories; the remainder after arrival at camp.[11]

In September, 1917, the entrainment of the men of the first call for the first draft was made, other calls succeeding one another rapidly through the remainder of the year. Boards of examiners could not be organized in number sufficient to effect the primary examination in the first draft, but the troops of the National Army were reexamined by special examiners, chiefly in the early part of 1918.[12] The reports show that 361,314 men were reexamined, with the detection of 2,435 cases of tuberculosis, or 0.673 per cent. Discharges for pulmonary tuberculosis on certificates of disability, from the entire Army during the war, chiefly as the result of reexaminations by special boards, numbered in all, 11,362. According to the report of the Surgeon General for 1918, up to March, 1918, 1,200,990 men had been reexamined and 9,648 had been recommended for discharge for pulmonary tuberculosis, a percentage of 0.803.[12]

At the time of the second draft, orders were given by the Surgeon General that there should be but one examination of drafted men after their arrival at camp, except in doubtful or deferred cases, the necessary specialists functioning in the primary military examination instead of going over the command at a later time as boards of revision.[13] All of the procedures necessary for the admission of an individual, comprising the physical examination, the administration of vaccines, and the entries upon the prescribed blank forms, were to be completed in a single day.

This change, so far at least as the physical examination was concerned, was a long step in advance, the examiners by this time having become thoroughly familiar with their duties. A difficulty at once arose, however, from the speed required in the examinations. Circular No. 20 prescribed that each examiner should examine at least 50 men per day. This number, regarded as excessive by many at first, was frequently doubled by the more alert after they had gained experience. The usual size of the board of tuberculosis for the larger camps was 10 members. If such a board examined 1,000 men per day, that was certainly all that could be required of it. Yet in some instances the orders of the War Department or of the camp commander contemplated much greater speed. Representations were made by the Surgeon General to the effect that haste necessarily resulted in insufficient examinations and that, in view of the fact that only one examination was required, it was of the highest importance that that examination should be thorough. This resulted in some improvement in the conditions, but in general the work that was required remained excessive. In some instances the boards worked all day and far into the night, or again worked all night instead of all day in order to complete their tasks within the time prescribed.[11] The number of examinations made at times seems almost incredible. Thus, 1 team of 3 examiners examined 1,763, 1,854, and 1,944 men in 3 successive days. Rapid work of this kind was made possible only by the assistance of enlisted men of the Medical Department, who instructed the recruits in advance of their appearance before the examiners how to stand, how to breathe, and how to cough. The attention of the examiners was directed solely to the auscultation of the lungs for the presence of râles after expiration and

cough, cases which showed moist sounds being referred for more careful examination. That an objective condition was revealed with remarkable regularity by this method is shown by the fact that when the number of men examined was large the cases rejected always amounted to between 0.5 and 0.6 per cent of the men examined.[11]

As stated above, with the increment of the draft called on March 26, 1918, primary examinations were first undertaken by the tuberculosis examiners. The total number of men rejected for pulmonary tuberculosis on primary examination in the second draft was 12,629 out of 2,040,051 examinations, or 6,174 per million. The grand total of examinations, including both reexaminations and primary examinations of recently recruited soldiers and of incoming drafted men, by special tuberculosis examiners was 3,288,669, the total number of men rejected by these boards being 22,596 or 6,871 per million.[11]

In addition, the boards discovered 1,461 cases of pulmonary tuberculosis which were held to limited or special service in this country, 108 cases of suspected tuberculosis, and 613 cases of tuberculosis in organs other than the lungs. The total number of cases discovered by special examiners amounts to 26,173.

From November, 1918, the examining boards were chiefly engaged in examinations previous to demobilization, 2,500,662 men having been examined up to June 30, 1919, of whom 1,356 were found to be tuberculous, or 542 per million.[11] This gratifyingly small ratio of tuberculosis cases undoubtedly would have been still further reduced if all of the men demobilized had been submitted to earlier thorough examination for tuberculosis. Records are available from Camp Lewis, Wash., from which it appears that 63,575 men were examined there for demobilization.[14] Of these, 8,500 who had not previously been examined by any board yielded 57 cases of tuberculosis, or 0.67 per cent; i. e., 6,700 per million; while among 55,075 men who had been examined at Camp Lewis, but 9 cases of tuberculosis were discovered: A percentage of 0.016, or 163 per million. It was pointed out further that at United States General Hospital No. 21, which received the tuberculous patients from organizations belonging to the Pacific coast and the neighboring inland Northwestern States, there were 183 cases of pulmonary tuberculosis from the region referred to, of which 170 were not mustered at Camp Lewis.[14] Nine came from Camp Lewis but were not examined there, since they belonged to a group of 3,626 men of the first draft who were sent away before they could be examined. Four had been examined one of whom had been recommended by the board for discharge, but not discharged, leaving but 3 out of 13 cases for which responsibility could be fairly attached to the Camp Lewis board. Cases of pulmonary tuberculosis from the above mentioned States would naturally, in great part, be sent to United States General Hospital No. 21. Such data go far to prove that, given a sufficiently thorough and efficient examination, tuberculosis could be practically eliminated from an army. The cases that break down under the stress of military service are largely those entering with lesions capable of detection by experts.[14]

Over 600 physicians acted as tuberculosis examiners, but the number of examiners available was never sufficient for the needs of the service; so, as a rule, it was necessary to confine their activities to the larger camps, with special

reference to the examination of troops who were to go abroad. Unfortunately, the work of reexamination could not be organized in time to examine many of the troops who were sent overseas early. More than 40,000 soldiers were sent abroad, therefore, in the early months of the war of whom few could have been reexamined for tuberculosis.[11] Some organizations likewise were embarked for Europe at a later time which escaped reexamination, as, for example, many of the hastily assembled stevedore regiments, the difficulty being partly due to the failure to learn in time of the existence or of the contemplated departure of the organizations, military operations and especially embarkations being shrouded in the utmost secrecy, and partly to the scarcity of examiners.[11]

How necessary reexamination of the colored enlisted men composing the stevedore regiments was, is shown by the fact that a special board at Newport News, Va., examined 8,734 men of colored stevedore regiments and reported 68 cases of tuberculosis, or 0.812 per cent.[11]

In addition to the work of examination of organizations, tuberculosis experts were detailed as specialists of divisions and of base and general hospitals, as officers of tuberculosis hospitals, and as instructors.

When the need of examiners was greatest, physicians were employed temporarily as contract surgeons in order to assist in the examinations. As the qualifications of these contract surgeons were not always known, it was soon found advisable to give them a course in physical diagnosis of the chest, the primary object being to observe their work and to classify them according to their proficiency. This course, however, met with unexpected success and became popular among the medical officers. Its benefits were so manifest that from the original school, at the Army Medical School, Washington, instructors were sent out who established like courses of instruction at the medical officers training camps at Fort Oglethorpe, Ga.; Fort Riley, Kans.; and Fort Benjamin Harrison, Ind.[15] A school was instituted at a later time at General Hospital No. 16, New Haven, Conn., in which, in addition to courses in physical diagnosis, instruction was imparted in the treatment of tuberculosis and in hospital administration, with a view of training medical officers for service at tuberculosis hospitals. Courses in physical diagnosis also were given to the medical officers of various camps and hospitals by travelling instructors.[16] Especial attention was paid in this course to the physical signs of the normal chest.

At the beginning of their work the chief function of the special examiners was necessarily eliminative; they were to rid the Army of the tuberculous. But they also appreciated the fact that quite as important a duty was conservation. Of their own initiative many of the boards stamped the records of the soldier "Examined and passed by the tuberculosis board," with a view of preventing the later discharge of individuals presenting signs which the inexperienced might misinterpret.

The inexperienced diagnostician finding signs which may be those of tuberculous disease usually recommends discharge, giving himself the benefit of the doubt, in the fear that he will be thought to have overlooked what should have been found if at a later time the bearer of the signs in question should be diagnosticated as tuberculous. The specialist should strive to retain in the service men in whom he thinks tuberculosis is not active notwithstanding the

presence of signs or symptoms which some might misinterpret. The conservation to the service of men with blemishes which do not disqualify is one of the most important of his functions. His duty is not only to secure the rights of the individual; it is fully as much his duty to protect the Government, which should not unnecessarily be deprived of soldiers when every man is needed. He who in time of war excuses men for trifling or doubtful deviation from the normal does not properly conceive his duty toward his country. There is no reason why the possibly tuberculous alone should be excluded from risks.

This view was emphasized in Circular No. 20 and was enforced as far as practicable. But it remained one of the chief difficulties that medical officers were reluctant to take a definite stand with regard to many cases, that in some camps, wards were filled with apparently healthy men kept under observation whose supposed deviations from the normal had been discovered only in routine examinations, as if the desideratum was to make a positive diagnosis of tuberculosis at all costs. The chief reason for this course was the fact that some one had diagnosticated active tuberculosis in these cases. It was undoubtedly of great benefit that a standard had been provided in Circular No. 20, upon which the examiner could rely and which relieved him of some of the burden of his responsibilities in the diagnosis of disputed cases. A standard, though imperfect, is believed to be an indispensable adjunct in Army tuberculosis work not only to support the examiner but also to secure the necessary uniformity of practice in the matter of discharge for tuberculosis.

OCCURRENCE

IN CAMPS IN THE UNITED STATES

When considered by camps of occurrence, during the World War, two camps only are found to be outstanding in this respect, namely, Camps Kearny, and MacArthur. Camp Kearny (situated near San Diego, Calif.) had the worst record for tuberculosis of all the large Army camps.[17] In the reexamination of 19,827 men at this camp, 853 cases of tuberculosis were discovered, or 4.83 per cent. The admissions for tuberculosis at Camp Kearny in September, October, November, and December, 1917, were at the rate of 157.53 per 1,000 of strength, Camp MacArthur, Tex., the second worst camp in this respect, having the comparatively small ratio of 25.45. Camp Kearny was primarily a National Guard camp. It received 6,944 men of the National Guard from Arizona, New Mexico, Colorado, Utah, and California in September and October, 1917, and 13,680 men from other camps in November, largely drafted men. During 1918, also, additions were received largely from other camps.[18]

Matson's remark with reference to Camp Lewis [14] that the material was largely from the Southwest and contained enormous numbers of health seekers whom the boards of the first draft sent, thinking that change of climate might benefit the manifestly tuberculous, undoubtedly applies with even greater force to the command at Camp Kearny.

The operation of this tendency above referred to is still more clearly exemplified at Fort MacArthur, Calif. Here in 501 men examined for tuberculosis, 103 cases were found, a rate of 20.55 per cent.[11] On investigation it was found that the large majority of these men were drafted from Texas, 53 towns in that

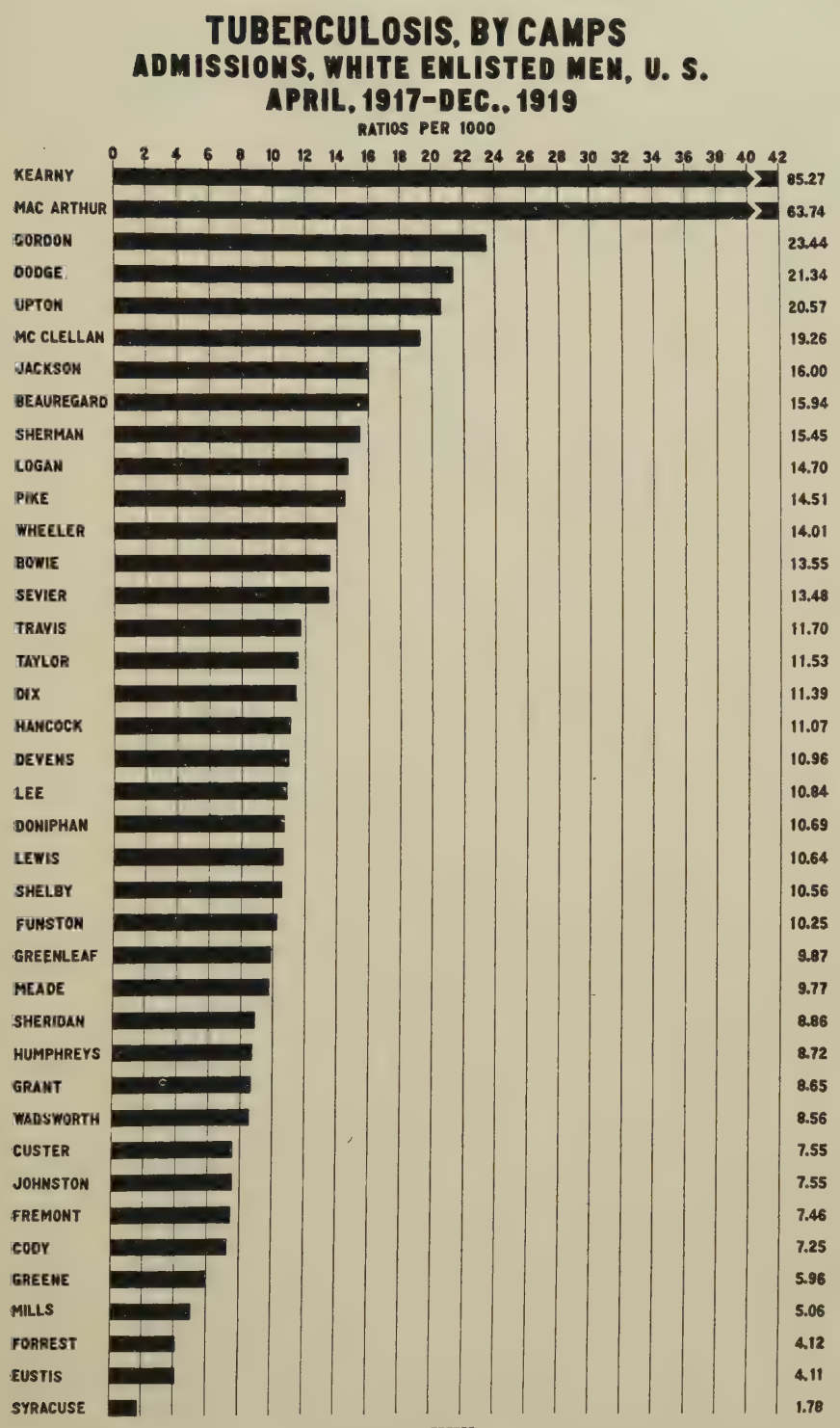
TUBERCULOSIS, BY CAMPS
ADMISSIONS, WHITE ENLISTED MEN, U. S.
APRIL, 1917-DEC., 1919
RATIOS PER 1000
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42
KEARNY 85.27
MAC ARTHUR 63.74
GORDON 23.44
DODGE 21.34
UPTON 20.57
MC CLELLAN 19.26
JACKSON 16.00
BEAUREGARD 15.94
SHERMAN 15.45
LOGAN 14.70
PIKE 14.51
WHEELER 14.01
BOWIE 13.55
SEVIER 13.48
TRAVIS 11.70
TAYLOR 11.53
DIX 11.39
HANCOCK 11.07
DEVENS 10.96
LEE 10.84
DONIPHAN 10.69
LEWIS 10.64
SHELBY 10.56
FUNSTON 10.25
GREENLEAF 9.87
MEADE 9.77
SHERIDAN 8.86
HUMPHREYS 8.72
GRANT 8.65
WADSWORTH 8.56
CUSTER 7.55
JOHNSTON 7.55
FREMONT 7.46
CODY 7.25
GREENE 5.96
MILLS 5.06
FORREST 4.12
EUSTIS 4.11
SYRACUSE 1.78

CHART XXV

State having contributed 92 of the tuberculous cases. In any case, of course, it by no means fairly represented the drafted men of the State. Indeed, there was collected in the five howitzer companies at Fort MacArthur what in all probability constituted the majority of the tuberculous cases of the part of Texas from which the men originally came. There could hardly be more startling proof of the inefficacy of the usual routine examinations and the need of revision. The evils of the absence of an efficient medical examination previous to the transfer over long distances of large bodies of troops is also apparent enough.

New Mexico had the undesirable preeminence of furnishing the greatest number of tuberculous men per 1,000 of native population of any of the States of the Union.[18] Yet there are regions in New Mexico where the climate is probably best adapted of any in the United States for the treatment of pulmonary tuberculosis, its reputation for the climatic treatment of the disease being shown by the fact that the only sanatoria which were operated by the Army and by the United States Public Health Service before the war for the treatment of the tuberculous were located with in its borders. Like the other border States of the Southwest, New Mexico is overrun by consumptives from other States, many of whom were imported originally as patients in the Army and Public Health Service sanatoria, though many others came in as civilians. This latter class contains, as a rule, cases of pulmonary tuberculosis of more than average severity, many patients who fail to improve in the North being sent to the Southwest as a place of last resort. Moreover the popularity of the Southwest as a resort for the treatment of consumption is of comparatively recent origin. Consumptives have visited the region from the first days of its occupation by the whites, but not in considerable numbers until within recent years. It is improbable, therefore, that a sufficient number of sons of military age have been born to the immigrating consumptives to affect materially the ratios of tuberculous cases to native population. But the numerous patients discharged from the Government sanatoria would naturally more readily find openings in civil life in a part of the country with which they have become familiar, and the climatic advantages of New Mexico would be expected to induce tuberculous civilians in general to make it their home in a larger percentage than would be the case in the hotter climate of Arizona and Texas. Such men, many of them familiar with Army life and fond of adventure, many of them, too, perhaps alive to the prospects of future benevolence of the Government to tuberculous soldiers, would naturally seek enlistment in the Army and would conceal as far as possible the suspicious fact that they were originally from other States.

Another factor which should be considered is the Mexican element of the native population of the State, which composed 15 per cent of the population of the southern tier of counties in the census of 1910, since which time many thousands of Mexicans, fleeing the civil war in Mexico, have immigrated to New Mexico and to the adjacent portions of Texas and Arizona.

Physicians connected with the Atchison, Topeka & Santa Fe Railway medical service have noted that when Mexicans from remote districts are employed as laborers along the railroad a certain proportion of them suffer from acute forms of tuberculosis.[19] Here, according to well-known epidemiological

laws, we have an illustration of what befalls individuals not all of whom have received the more efficient immunization against tuberculosis afforded by life in a civilized community; the men fall sick from tuberculosis not because the environment from which they come has too much but because it has in a sense too little tuberculous infection! In other words, the tuberculosis is acute because it attacks the nonimmunized or imperfectly immunized individual.

About one-third of the population of the northwestern quarter of New Mexico is stated to be composed of Indians, and there are large reservations elsewhere in the State. The various tribes differ widely as to the prevalence of tuberculosis. No recent statistics of value are available, but it was reported some years ago with regard to the Zuni Indians that tuberculosis was rare among them, but that the mortality of the disease was 100 per cent.[20] Such a group would figure more largely in the statistics of mortality from tuberculosis than in the percentages of rejection upon admission to the military service; but the Indian as well as the Mexican element of the population is in general likely to become suspicious in the statistics which relate to tuberculosis. Unfortunately, the statistics as collected by the Provost Marshal General do not permit the determination of the race of the soldier. We are left to conjecture, therefore, as to the relative importance of the Indian and the Mexican in causing the high percentage of incidence of tuberculosis in New Mexico. The problem is highly complex, and it would be manifestly misleading to institute comparisons between a population like that of New Mexico, with its large percentage of health seekers and its admixtures of semicivilized races, and the more or less homogeneous American population of other portions of the United States.

IN THE AMERICAN EXPEDITIONARY FORCES

The care exercised in the United States in the elimination of tuberculosis from our Army was abundantly rewarded by the absence of any extensive prevalence of the disease among the troops in France. Cabot reported from Base Hospital No. 6 at Bordeaux that of 21,738 patients received at that hospital between September, 1917, and November 22, 1918, there were 63 positive cases of tuberculosis, pulmonary and extra-pulmonary—a percentage of 0.289.[21] Of these, 51 were recognized by the presence of tubercle bacilli in the sputum and 12 were found post mortem. One hundred other cases were diagnosed as probably or possibly pulmonary tuberculosis, no other diagnosis seeming more likely, though bacilli were not found in the sputum. None of the 163 were apparently incipient cases. The incidence of tuberculosis was greatest in the early months, he says, when presumably the "combing out" of tuberculous cases by special examinations in the training camps of the United States had not begun, or was not extended to all units. Stevedores, labor companies, and engineers were especially affected. In the first 7,000 cases treated at Base Hospital No. 6 there were found 35 out of the 51 positive tuberculous cases, while in the last 6,000 cases received only 1 case was proven tuberculous. Cabot's conclusions are:[21]

(1) Pulmonary tuberculosis was of rare occurrence among the sick treated at Base Hospital No. 6. (2) It occurred chiefly among soldiers who had not been specially examined in the training camps of the United States with reference to its presence. (3) An even three-

fifths of the 51 cases with tubercle bacilli in the sputa occurred in the cases between No. 1 and No. 7,000 of our series, while in the last 6,000 cases received only 1 case was proven tuberculous. (4) Few, if any, cases could have been considered as originating in line of duty. No incipient cases were recognized.

These observations by an experienced diagnostician located at a hospital at a port of embarkation through which many patients were evacuated to the United States and where, consequently, tuberculous cases must have abounded if the disease had been of frequent occurrence, are the more valuable because tuberculosis, not being a problem of magnitude in the American Army abroad, officers of hospitals, overwhelmed as they were at times by patients with wounds or acute infectious diseases, have remarked but rarely as to its prevalence. After tuberculous patients began to return to this country it was soon reported that a considerable percentage (sometimes as high as 50 per cent) had no clinically recognizable tuberculosis. It being important from a military standpoint that the Army abroad should not be drained of its men unnecessarily, a tuberculosis expert was sent to France with a view of securing a better diagnosis of tuberculous conditions. This visit culminated in an order being issued in the American Expeditionary Forces to the effect that only cases with tubercle bacilli in the sputum should receive the diagnosis "pulmonary tuberculosis," all other suspected cases to be classified as "tuberculosis observation." [22] Three centers (Base Hospitals Nos. 20, 3, and 8) were designated to which cases under observation should be sent.[22] No men were to be sent home as tuberculous unless their sputa contained tubercle bacilli or they had been passed as tuberculous at one of these centers. These measures rapidly reduced almost to zero the percentage of returning patients who were found to be negative for clinical pulmonary tuberculosis after observation in this country. But after the signing of the armistice, when retention of every possible man was no longer necessary, the above mentioned precautions were discontinued and large numbers of men who were simply suspected of having tuberculosis returned with a positive diagnosis of that disease. In all, 8,717 cases of pulmonary tuberculosis were received from Europe at the tuberculosis hospitals of the United States up to December 3, 1919.[23] In a total number of admissions to these hospitals amounting to 18,713 the diagnosis of pulmonary tuberculosis was not confirmed in 4,305.[23] What proportion of these negative cases came from Europe is not known.

EPIDEMIOLOGY

In the enrollment of millions of men in the United States and in the mobilization of the large European armies we have experiments on a grand scale in the epidemiology of tuberculosis which can not be too carefully studied. In our Army in France certain observations were made which led to the belief that our soldiers were in danger of primary infection with tuberculosis.[24] Glomsett remarked at the Red Cross Conference on Tuberculosis held in November, 1918, at Paris[25] that it was a pleasant surprise to learn that tuberculosis had played such an insignificant rôle, only 2.5 per cent of deaths having been due to this cause. Tuberculous lesions were found by him in 16.6 per cent of bodies of soldiers examined. He found "primary foci" in 50 per cent of his autopsies and stated that such foci were more common in the bodies of those

who had died from other causes than in those who had died of tuberculosis, persumably meaning old foci. He found no evidence of tuberculosis in fully two-thirds of fibrous pleurisies. He had six autopsies of soldiers who had died of tuberculosis, four of which showed miliary tuberculosis. At the same conference Robertson [25] reported that he had worked during the first year of the war in Freiberg, where of 100 autopsies of German soldiers 70 per cent showed tuberculous deposits in lungs or tracheobronchial glands, while in autopsies on our soldiers he was able to detect tuberculosis in less than 25 per cent.

Each pathologist, it appears, had his own standard, and the results of autopsy findings differed as widely as did the standards. The number of autopsies considered, moreover, is much too small to indicate the true status of soldiers as to tuberculosis. Caseation of lymph glands was referred to by some of the observers in support of their position without, however, giving a description of the exact condition of the glands. The behavior of the lymph glands in a given case is fundamental for the decision as to the nature of the tuberculosis that is present.

It may be remarked here that the pathology of lymphadenoma is admittedly dubious as to etiology and especially as relates to the rôle of the tubercle bacillus in the production of suppurative processes. The presence of local lesions in the vicinity of the glands, carious teeth, and the like is very significant. It would seem that a mixed infection, one infective agent which is active in the production of an unusual type of lymphadenitis being unidentified, would best explain the facts. Why should tuberculosis, if uncomplicated, pursue so unusual a course? At all events there seems to be no good reason why it should be necessary to assume continued new infections from without, and much that speaks against that hypothesis. The fact that notwithstanding the supposedly frequent reinfections the disease remained localized and the patient was in good health is the best evidence of the persistence of an immunization. A primary infection or an infection which sprang from a serious diminution, if not an entire loss, of a former immunization would tend to become generalized and fatal. This is well illustrated by the course of tuberculosis among the colonial troops of the French Army, as reported by Borrel.[26] This command, the average strength of which was 50,000 men in 1917–18, was composed of negroes from Madagascar and Senegal, of Annamites, and of Kanakas. The Malgaches or Madagascans had tuberculosis of a chronic type—tuberculosis is not a rare disease in Madagascar. The Annamites, among whom the disease has long prevailed, had but a small percentage of tuberculous cases. Tuberculosis was found in about 10 per cent of the Kanakas; the disease had a duration of months and often of years. Enlargement of the cervical glands of a scrofulous type and of a chronic course, which was apparently often not incompatible with good health, was common among them. But the Senegalese were the most severely affected with tuberculosis. This is a rare disease in Senegal outside of the towns where there is contact with Europeans.

Borrel found only 4 to 5 per cent of positive reactions to the skin test among newly arrived recruits, but unfortunately used tuberculin diluted to one-tenth strength. Apical tuberculosis was found in not more than 5 per cent of the

Senegalese. Those who had the chronic type of tuberculosis came from the towns. They spoke French. While in the command considered as a whole 50 per cent of the cases of tuberculosis were of the chronic European type, among the Senegalese who came from country districts the type of tuberculosis was that of the European infant; that is, it was primary tuberculosis. In these patients there was generally a chain of enlarged lymph glands extending from the supraclavicular or the superior cervical glands to the hilus, the largest ones of about the size of a hen's egg, having a location corresponding to that of the primary lesion—which might be situated upon the tonsil, in the posterior pharynx, the larynx, or at the level of the main bronchi; but in 80 per cent of the autopsies the disease began in the tracheobronchial glands. More than 70 per cent of the deaths from tuberculosis among them were due to miliary tuberculosis in which the lungs were not more involved than the other organs. There was sometimes a massive caseous pneumonia from direct rupture of an enlarged gland into bronchi and alveoli, the gland then often becoming the center of a great caseous mass. Or there might be primary pleurisies without caseous foci in the lungs, or more than one serous membrane might be involved simultaneously, the peritoneum as well as the pleura. Clinically after what Borrel calls the initial glandular period, lasting one to three months, in which there is no fever, the period of generalization comes on with high and irregular fever and death in from 15 days to 1 month; rarely 2 months.

Roubier's account of this disease confirms that of Borrel. He called attention to the constant presence in miliary tuberculosis of caseous mediastinal glands, sometimes so voluminous as to give rise to symptoms of compression.[27]

The important contribution of Borrel gives in epitome the entire pathology of tuberculosis. We see chronic localized pulmonary tuberculosis in soldiers who had been long exposed to infection, the scrofulous type, still chronic, with chronically caseated lymph glands in the imperfectly immunized Kanaka, but in the virgin soil of the Senegalese acute and enormous enlargement of glands, rapid generalization of tuberculosis, and death. It has been known from animal experiment that if the infected animal survives the primary inoculation with tuberculosis the glands acquire a certain immunization, such that they do not swell materially or at least long remain swollen in subsequent inoculations, irrespective of the fact that the animal may in reality be slowly dying as the result of the first inoculation. The same is true of man except so far as the picture is confused by the chronic caseations and suppurations of the scrofulous type. If, then, there be not found a primary lesion with enlargement of the corresponding gland, as Borrel described it, the case is not one of primary tuberculosis. Immunity is generally completely lost in the last stage of fatal human tuberculosis; miliary disseminations of tubercle shortly before death, throughout the internal organs, whether macroscopic in size or only to be determined by the microscope, are well-nigh the rule in uncomplicated cases. The glands do not swell in this secondary miliary tuberculosis, but they may be found, of course, chronically enlarged and caseated in the scrofulous type.

Evidence of chronic tuberculous changes is found in some cases of pulmonary tuberculosis with acutely fatal termination. That they are not found in all such cases which occur in civilized man is largely accounted for by the

difficulties of the search. Even Nägeli in his classical investigations which finally resulted in finding tuberculous changes present in 97 to 98 per cent of autopsies, at the beginning found only 40 per cent.[28] Opie [29] showed the surprisingly large number of calcifications to be detected in the lungs by his method of radiography, most of which would have escaped detection by the ordinary methods of search. Since civilized adults are shown by tuberculin tests to be infected with tuberculosis in almost 100 per cent, it is more logical to assume that the few whose evidence of past infection is not discovered have really been infected than that they should have escaped entirely the ubiquitous tubercle bacillus. Acuity of course and of termination of tuberculous disease is encountered in many cases in which earlier infection with tuberculosis is demonstrable. They should not, therefore, be considered to indicate a primary infection though earlier tuberculous changes may not be detected, certainly not unless the case presents the characteristics of truly primary tuberculosis.

The experience of the British Army in France with Africans was somewhat similar. Thus Cummins [30] stated that there were 165 deaths among British troops in 2,881 cases, which gives a case mortality of 5.7 per cent, while in the South African labor corps units consisting of "Cape boys" and Kaffirs there were 183 deaths in 372 cases of tuberculosis, a case mortality of 56 per cent. According to the same writer, the Indian divisions in France in 1916 had a tuberculosis incidence of 27.4 per 1,000, that of the British troops being 1.1 per 1,000. In comparing the mortality rates from tuberculosis, allowance must be made for the probability that in the British Army all but the most acute cases would be repatriated and that deaths which occurred after discharge, and perhaps after the individual had been returned to Great Britain though still in the service, would not appear in the mortality statistics in France, while the tuberculous negro would probably not be sent to his home. The relatively high death rate of the Africans, however, shows clearly enough that the negroes of South Africa are but imperfectly immunized against tuberculosis. The result of such imperfect tuberculization in these troops, including the Indian contingent, was a higher relative mortality from tuberculosis, though they had the same food, clothing and shelter as the white troops. If the American troops had been imperfectly tuberculized, instead of a surprisingly low death rate from tuberculosis, the mortality would have been high. The acute forms of fatal tuberculosis among our soldiers were, then, really quite exceptional. To account for such exceptions on the hypothesis of entire absence of previous opportunity is much more difficult in the case of men who do not appear to have been a peculiar class as respects their origin, mode of life, etc., than by the more natural supposition that they differed from other tuberculosis cases only in the fact that the course of their disease was more rapid; perhaps, as some German writers suggest, the fatigues and hardships of war had something to do with this outcome.

From the epidemiological standpoint the cutaneous tuberculin test is a valuable and harmless method of obtaining an approximate notion as to the degree of tuberculization of a group of individuals. It was employed for this purpose in our Army in two instances. At Coblenz 159 American soldiers between the ages of 18 and 30 years, with no family history of tuberculosis and

for the most part men of athletic build, were tested with undiluted "old" tuberculin.[31] Of these, 122 (76.7 per cent) reacted postively to the first inoculation, 26 to the second (giving a percentage of 93 positive in either the first or second test), and 3 to a third inoculation; which results in a total positive percentage of 94.9, 8 of the soldiers remaining negative. The distinction was made in this group between country dwellers, city dwellers, and (small) town dwellers, but such slight difference as existed between these subgroups showed that the men from the country were infected with tuberculosis in a very slightly larger percentage than the men who came from towns and cities, the positive percentage in the first, second and third tests combined being 96.9, 90, and 96.2, respectively, for the subgroups in the order given above. Unfortunately, the regiment to which these men belonged, being on the eve of return to this country, it was impracticable to test further those who had failed to react.[31] A similar test was made at General Hospital No. 21, Denver, Colo.[32] One hundred soldiers between 21 and 30 years of age belonging to the Medical Department detachment of the hospital, but employed in outdoor occupations which did not bring them into contact with the patients (this institution being a hospital for the treatment of tuberculosis), were tested in the same way as in the preceding experiment. In the first cutaneous test 71 were positive, 29 negative. The negative cases received a second inoculation after five days, 24 becoming positive and 5 remaining negative. This gives a positive percentage of 95 for the two inoculations. One of the 5 negative cases was discharged at this time; the remaining 4 were further tested by subcutaneous injections of old tuberculin. All were negative to 1 mg. and likewise failed to react to 5 mg. To the injection of 10 mg. 3 reacted positively. A fourth injection of 20 mg. was given to the man who remained negative. Though there was no rise of temperature after the injection, it was considered to have resulted positively on account of the "depot" reaction. Thus by following up the cases negative to the skin test with the subcutaneous injection, 100 per cent of positive reactions to tuberculin was obtained in 99 men.[32] The above observations correspond closely with the results obtained by Freund,[33] 95.1 per cent of Austrian soldiers positive for the cutaneous test, and to those reported by Hamburger, 98 per cent of Austrian soldiers positive to the "stitch" reaction.[34] The importance of recording such tests as those described lies in the light which they throw upon the claim that our soldiers are to a considerable extent unprotected by a precedent tuberculization against primary infection with acute and fatal forms of tuberculosis.[32]

DIAGNOSIS

In the view of many who belong to what we will call the school of ultra-refined diagnosis, pulmonary tuberculosis begins in the apex of the adult lung, as a rule. Incipient tuberculosis of the apex can be recognized at a very early stage, before the occurrence of râles, by slight changes in breath sounds and percussion note, even by certain symptoms before physical signs are present.

Others hold that tuberculosis of the lungs begins at the hilus, usually in childhood, and in favorable cases advances at first as a tuberculous lymphangitis along the blood vessels and bronchi. Tuberculosis of the apex is not incipient but advanced tuberculosis. The signs relied upon for the diagnosis of incipient

tuberculosis are not evidences of a new infection, but, so far as they are not normal for the part, are signs of old, perhaps obsolete, affections of the apex which are exceedingly common, and, unless they extend widely beyond the apex or have resulted in cavity, do not necessarily demand the exclusion of the individual from the military service. The only signs of true activity of the tuberculous process are moist râles.

It should be possible to ascertain within a few years what has happened to the men who have been discharged for supposed incipient tuberculosis. If that diagnosis was correct the incipient cases should in part at least have gone on to develop manifest tuberculosis of the lungs. If such men are not discharged on account of their incipient tuberculosis and if tuberculosis is readily transmissible from one adult to another, each one who remains in service would form a center of infection for his healthy comrades, who, moreover, are likewise endangered through contact with the seriously infected civil population in billets and the like. Hence pulmonary tuberculosis is likely to grow worse in the Army the longer active service continues.

If the opposing view is correct, however, the elimination of the tuberculous individual from the Army would result in freeing the Army from tuberculosis in direct proportion to the perfection of such elimination. Such cases of active tuberculosis among soldiers as have escaped notice will break down under the conditions of military service if the disease is extensive and be successively eliminated so that active chronic pulmonary tuberculosis will become more and more rare.

The evil of the ultrarefined diagnosis of pulmonary tuberculosis is most conspicuously exhibited in the now celebrated 86,000 soldiers of Landouzy,[2] who, it was generally believed, had become infected with tuberculosis in the military service, a fact that not unnaturally excited considerable apprehension in the United States lest a similar evil befall American forces. But, according to Lereboullet,[35] M. Godert reported to the Senate from the War Office that from August 2, 1914, to October 31, 1917, 80,551 men were discharged for disability from tuberculosis not incident to the military service (réformés No. 2) and 8,879 men for disability in line of duty (réformés No. 1) from the same cause. The evil is infinitely less severe, M. Godert remarked, than the figures seem to show without explanation, for 65,000 were determined to be tuberculous in the first year of the war and were eliminated without having been incorporated into, and therefore without having contracted their disease in, the army. From January to October, 1917, 4,839 men were discharged from the army for tuberculosis without pension and 6,863 were pensioned. This relieved the French Army of much of its bad reputation as creator of tuberculous infection, but it remained to consider the diagnosis in this large group of over 80,000 men. Late in 1917 a cablegram was received in Washington from the French War Office which stated that at that time it was believed that less than 50 per cent of this group were really tuberculous. These figures, however, are most conservative, for Rist,[2] an undoubted authority, states that when clearing stations were established for the purpose of securing a better diagnosis of tuberculosis, of the first 1,000 cases examined at one of them only 193 men were found to have active tuberculosis. He thinks that we are justified

in believing that out of the 86,000 soldiers discharged from the French Army during the first year of the war less than 20 per cent were really tuberculous, and adds "my personal impression is, much less than 20 per cent." Many of these men no doubt had other diseases, but in all probability it would not be an exaggeration to say that several divisions of soldiers (assuming 10,000 men for a division) might have been added to the French Army by a more correct diagnosis of tuberculous conditions at a time when France was most sorely beset. Between August, 1914, and December, 1918, 111,038 French soldiers were discharged for tuberculosis, of whom 25,600 were pensioned and 85,438 were granted no pension. There were 12,220 deaths from this disease in the French Army. France mobilized 8,410,000 men during the war.[36]

Conditions were nearly as bad in Germany. Fraenkel,[37] one of the most distinguished of German internists, writing in 1916, said that in the endeavor to recognize tuberculosis as early as possible we have arrived at an overestimation of various relatively insignificant phenomena. Of those diagnosticated as tuberculous, only 40 per cent were really so; 40 per cent had other diseases; 20 per cent had no disease at all. Blümel reports that of officers and men who had been declared temporarily or permanently incapacitated for military service on account of pulmonary tuberculosis, about 80 per cent of those whom he examined proved not to be tuberculous.[38] Nevertheless the tuberculosis situation in the Army of Germany seems to have become highly satisfactory, for the errors of diagnosis complained of consisted in diagnosticating tuberculosis too readily rather than in failure to find the disease when it was present in a manifest form. Goldscheider [39] stated expressly that the overlooking of slight manifest conditions seemed to have rarely occurred.

Experience in our Army has long shown that pulmonary tuberculosis is discovered in the majority of cases in the early months of military service. But men with small and chronic tuberculous lesions (and occasionally with surprisingly large lesions) are often unconscious of their disease.

In connection with diagnosis, and particularly as regards tuberculosis as a cause of rejection for military service, Circular No. 20, quoted above, was written from the standpoint of what may be called the regular school. Since it was designed especially for use in connection with the examinations for entrance into the Army, it does not take up the more acute forms of tuberculosis, but notwithstanding this omission it was used in the instruction of medical officers. No change of importance was made in its test, and the chief point upon which experience showed that more light was needed was the size of the obsolete lesion which would justify rejection. The efforts of medical officers to commit the Surgeon General's Office to the definition of such a lesion by extent as measured by inches or by ribs and vertebræ were resisted for the reason that not only the extension of a lesion but also the severity of the tuberculous process which gave rise to it (determined by the density of fibrous tissue, existence of cavity, and the like) was of importance. The most radical position taken was the insistence upon moist râles as the only physical sign which justifies the diagnosis of activity. There the writer was supported not only by his own clinical experience but also by the opinions of Piéry [40] of France, Goldscheider [41] of Germany, and many others.

The diagnosis of tuberculosis became more than ordinarily difficult during the war on account, first, of the prevalence of bronchopneumonia due to streptococcus infection which, with the exception of a sputum positive for the tubercle bacillus, sometimes gave all the classical signs of pulmonary tuberculosis, including hemoptysis. At a later period many unresolved pneumonias following influenza still further complicated a difficult situation. At some camps so many men were discharged without warrant for tuberculosis during these epidemics that it became necessary to issue the order that no one should be discharged with that diagnosis unless the sputum was found to contain tubercle bacilli.[42] This course met with many remonstrances at first but was finally approved by all as the only possible means of averting what promised to become a great evil. And, it may be pointed out, the requirement of a positive sputum was the more warranted because the tuberculosis imitated by other diseases was not the obscure and doubtful forms of the disease, but a frank and extensive tuberculosis which would almost without doubt be attended by sputum containing many tubercle bacilli. At a later time, in order to provide for cases still occasionally encountered, the order was modified to permit the report of old and extensive cases of fibrosis, though the sputum be negative, with a view to their discharge, the decision as to each case remaining, however, in the hands of the Surgeon General.[43] Such a limitation was proved to be necessary in practice because some medical officers (not specialists) appeared to be of the opinion that the denomination of cases as those of fibrosis was simply a device to get rid of any and all cases of supposed tuberculosis irrespective of the absence of any evidence of the existence of a large and old lesion.

Considerable pressure was exercised during the first months after the United States entered the war by a number of prominent physicians and radiologists to induce the Surgeon General to make the radiograph the decisive factor in the diagnosis of pulmonary tuberculosis. The claim was that the work could be done with great rapidity and accuracy, that the negatives were easily stored in a comparatively small space and would form a permanent and more or less infallible record which would not only be of great scientific value but would also decide better than the results of physical examination as to the necessity of rejection, 90 per cent approximately of the men being accepted on their radiographs without further examination of the lungs, leaving the remaining 10 per cent for further study. Even granting that all of the above claims were well founded, it was evident that the practical difficulties in the way of the adoption of this plan were insuperable. Not to mention the enormous cost of photographing the entire new Army and the impossibility of obtaining a sufficient number of plates within a reasonable time, the lack of trained radiologists had to be considered. How serious this objection was is shown by the fact that several X-ray schools were kept in operation for many months in order to train technicians who after the brief course of training could still hardly be regarded as experts in the determination of tuberculous lesions from the radiograph. A technical service of the magnitude required could evidently not be made ready to function efficiently until long after the time when the decisions of which it was claimed to be the most trustworthy

arbiter had perforce been made and the subjects for the most part dispatched overseas. A subcommittee of the general medical board of the Council of National Defense undertook a test to determine practically the merits of the proposed scheme. All of the members of certain companies of the 69th New York Regiment, National Guard (later renumbered the 165 Regiment of United States Infantry), were photographed by the X ray. Certain men diagnosed as tuberculous by this means were examined subsequently by an examining board composed of experts in physical diagnosis from New York City. For various reasons the total number of those who could be obtained for reexamination was only 25. Of these, 21 were found to have no abnormal physical signs, 1 had distinct signs of apical involvement with râles in both apices but no symptoms, and 3 had only slight or equivocal signs, of whom but 1 gave pulmonary symptoms. The last 4 men were rejected, 1 of them, however, not on account of physical findings, but because of suspicious history and radiograph. The board was disposed, as will be noted, to be most liberal in its concessions, but its findings can hardly be said to make out a good case for the method which in this instance was put into effect by skilled radiologists

How the method would have worked out at Army camps on a large scale is best shown by the experience at Camp Lewis, Wash.—a camp the medical records of which are more than usually accurate and detailed—with men of the second draft; that is, at a time when the X-ray services had become well organized:[44]

> Of 570 men rejected for clinically evident tuberculosis, the Roentgenologists recognized 54 per cent as tuberculous. In another group of 343 men, who, the Roentgenologists stated, were unqualifiedly tuberculous and should be rejected on X-ray findings alone, irrespective of physical findings, only 315 were rejected after physical examination. The remaining 28 were considered either to be nontuberculous or to have obsolete lesions and were accepted for service. We have been able to follow these men through their military career and none has developed tuberculosis. Among another group of 1,500 men whom the Roentgenologists diagnosed as very suspicious of tuberculosis, physical examination revealed only 128 cases of tuberculosis which were rejected. No cases of tuberculosis developed among the remaining 1,372 accepted for service.

The position taken in the Surgeon General's Office with regard to the X ray in the diagnosis of pulmonary tuberculosis was that while the radiograph is a very valuable, indeed, indispensable adjunct in the diagnosis, it can not be relied upon exclusively for that purpose because it not only fails sometimes to reveal early tuberculous changes but it also does not always indicate whether the lesions shown are active or obsolete.

Circular No. 20 forbids the general use of tuberculin for purposes of diagnosis in the individual case in Army examinations, the reasons for which hardly need to be set forth here. It may be remarked, however, that in giving the indications for the use of tuberculin in general an absolutely exact diagnosis of the condition of the lungs is always tacitly assumed as a preliminary to its administration. This assumption, however, can not be safely made with reference to the average medical officer any more than to the average practitioner in civil life. Tuberculin given blindly or with an incorrect appreciation of the degree of activity of the tuberculous process which may be present in the given case is a dangerous substance.

MANAGEMENT AND TREATMENT

The treatment of tuberculosis as a disease does not differ, of course, in military practice from the well-recognized rules that govern in civil life. Certain difficulties, however, are met in Army hospital management to which it may be well to refer briefly. Tuberculosis being the "social disease," every layman feels competent to hold opinions on the subject of its treatment, especially its climatic treatment, and the population readily divides itself into groups which hold differing views with regard to two questions. First, shall or shall not the tuberculous patient be discharged promptly; second, shall he be treated near his home or shall he be sent far away to climates reputed to be most curative for his disease?

The officers of charitable institutions and associations hold strongly to the view that the tuberculous individual shall be retained indefinitely in the Army. To many others it seems almost self-evident that he should be discharged as soon as the diagnosis is established. The anxious mothers, especially, who, in view of much unopposed criticism of the Army and of Army methods, not unnaturally are disposed to believe anything that is bad and are quite unprepared to believe anything good of Army hospitals, generally insist that their boys shall come home at once or at least be cared for in institutions near at hand. The treatment of the tuberculous near their homes has had many advocates, while, on the other hand, there are those who demand that they shall be given the advantages of the best possible climate.

With such difference of views the demands of the opposing parties to a certain extent neutralize one another. It adds greatly, however, to the labor of administration that so many feel justified in seeking to impose their views as to the proper procedure in a given case upon the Army authorities.

The desire of the Surgeon General was to retain the tuberculous in the Army for a considerable period, long enough for them to attain the maximum degree of improvement of which they were capable.[45] In a certain class of patients, those possessed of considerable wealth, the objection was raised that they were able to procure for themselves the best of sanatorium care and of medical treatment. With this class in view, an order was issued that patients might be discharged if they satisfied their commanding officers that they were able to provide and would provide for themselves care and treatment as good as that which they sought to relinquish. This provision was inevitably supposed to be a mere device for circumventing the regulations of the Army, and many illiterate affidavits from presumably poor persons as to plans for care and treatment were submitted in support of requests for discharge.

These difficulties were largely met by a campaign of education. In case of persistent application for the discharge of soldiers the aid of the nearest American Red Cross organization or tuberculosis association was solicited, which sent their workers to instruct the family as to the nature of the tuberculosis hospitals, the excellence of their medical officers, the aims of the Surgeon General, etc. Likewise the commanding officers of tuberculosis hospitals prepared circular letters which set forth the facts as to their hospitals in a similar way. In case some public man was insistent upon a particular soldier's discharge, he was asked if he was prepared to guarantee, personally, that treat-

ment and care equal to that furnished by Army hospitals would be provided for the man whose discharge he sought, and when discharged the Red Cross or other agencies were notified and sent in a report as to what had actually been done for the individual in question. By thus bringing home responsiblity for courses recommended and by educating the families which had been making trouble, much good was effected. The trouble making was found to be largely due to pure ignorance and baseless assumptions which a little well-directed effort served to dissipate.

Early in the war a circular inquiry as to the best size of tuberculosis institutions brought forth the unanimous opinion of the civilian experts that small sanatoria were better than large. Nevertheless, the scarcity of competent medical personnel and the greater difficulties in the way of building, organizing, and properly inspecting a large number of small hospitals led to the decision to depend, ultimately at least, upon a smaller number of large hospitals.

The chief objection raised as to the large tuberculosis institution is the loss of that close personal contact of the physician with his patient which is possible in the small groups. This would be a real objection if the care of the expert were necessarily exercised over a much larger number of patients in the large institutions. It is assumed by those who object that the chief alone will be competent to exercise the proper influence over his patients. But if the staff were composed of medical officers who were all equally competent, this objection would cease to have force. This is an ideal condition which, it must be admitted, is rarely attained anywhere. However, the method adopted in the Army to meet the above objections is worthy of consideration.

In a large tuberculosis hospital the patients are divided into sections by wards or other groupings. The commanding officer, if a tuberculosis expert—if not, the chief of service—selects the best assistants to be placed in charge of the individual sections. He is responsible for the selection of those in charge of sections, and should exercise the closest supervision over them, inspecting their work frequently, visiting also the individual patients at random from time to time to learn their views as to their treatment and what they have been taught as to their own cases, the reasons why they are treated as they are, etc. He should be accessible as to purely medical matters by all of his staff, who should look up to him as their chief counsellor and fellow worker. The medical officers in charge of sections exercise equal care in the supervision of their assistants. The endeavor is to enforce in every way a treatment, consisting largely in regimen, which can only be carried on with success if the patients understand what is aimed at and how they should cooperate with their physicians, and if they are made to see that their physicians are competent and are interested personally in their welfare. Such a treatment must necessarily be standardized in the sense that there shall not be a change of diagnosis and of treatment when physicians are changed or transfers of patients elsewhere effected; otherwise there is chaos. The endeavor was made to put into effect such a program, which presupposes a high degree of enthusiasm and much hard work. A good beginning was made toward its realization by the senior medical officers of our hospitals, but unfortunately the sudden cessation of the war interrupted, to a considerable extent, the development of the method to the

attainment of the best results, since there was a desire for discharge on the part of many medical officers, and a relaxation of the professional enthusiasm and of the energetic work which had been so gratifying during the war. The management of a large tuberculosis hospital demands a staff of the highest quality. With such a staff there seems to be no reason why the large tuberculosis hospitals shall not be conducted with success.[46] But the writer ventures to express, in this connection, an opinion in which he differs from many officers of our Army, which is that the commanding officer of such a hospital should himself be a tuberculosis expert, not a mere administrator. Either that, or he should be required to efface himself, so far as medical questions are concerned, in favor of the chief of the medical service. But the commanding officer, in the writer's judgment, is, by virtue of his official position, the officer who can best coordinate the activities of his subordinates.

Before the World War, Fort Bayard, N. Mex., was the only institution in the Army devoted exclusively to the treatment of tuberculosis. It had capacity of some 400 beds. Early in the war the William Wirt Winchester Hospital, at New Haven, Conn.—a hospital built in the most substantial manner expressly for the treatment of tuberculosis—was leased for the duration of the war. By the erection of temporary wooden buildings its capacity was increased to a total of 500 beds. A sanatorium at Markleton, Pa., and a hotel at Waynesville, N. C., were also leased for temporary occupancy and increased to the capacity of 270 and 500 beds, respectively, by the use of tents and the addition of wooden buildings. Permission having been granted early in the war to use land at Otisville, N. Y., belonging to the New York City Municipal Sanatorium, it was hoped that a hospital with a capacity of 650 to 1,000 beds might be well advanced in construction before the onset of winter in 1917;[47] but owing to various vexatious and unnecessary delays, chiefly due to the fact that the details of construction, of purchasing, and the like were required to be passed upon by many different departments, building operations were not begun until midwinter and the buildings were not ready for use until the summer of 1918. The capacity of the hospital was 650 beds. In the meantime a hospital with a 1,500-bed capacity was built at Azalea, near Asheville, N. C., and a permanent hospital was constructed at Denver, Colo., with foundations of concrete and walls of hollow tile, and with a capacity of 1,500 beds. The post of Whipple Barracks, near Prescott, Ariz., was also turned over to the Medical Department of the Army and its permanent buildings were supplemented at first by ward tents, at a later time by the construction of semipermanent hollow-tile structures, until the capacity of 500 beds was reached. Fort Bayard also was enlarged to a capacity of 1,000 beds by the erection of wards built of wood. At the time when tuberculous patients were being most rapidly returned from Europe, use was made temporarily of the base hospital at Camp Wadsworth, Spartanburg, S. C., as a tuberculosis hospital, with a capacity of 1,000 beds. The total maximum capacity of 6,650 beds, not including the hospitals at Markleton and Waynesville, was attained by these means.[48]

In making such provisions the greatest difficulty of course was the impossibility of providing properly and at the same time not excessively for the needs of an army the maximum strength of which could not be foreseen. The best

approach to a solution of such a problem is the choice of land and the preparation of plans in such a way that in case of need the hospitals can be enlarged without becoming cumbrous. Fortunately, since many tuberculous patients are benefited by an outdoor life, the use of tentage and of easily built shacks may avert temporarily the overcrowding of permanent buildings without causing serious inconvenience.

MORTALITY

Deaths from tuberculosis (primary admissions) during the fiscal year ending June 30, 1918, among officers and enlisted men in the United States numbered 422 (ratio per 1,000 average annual strength, 0.35) and in Europe 389, the ratio per 1,000 average annual strength being 0.39. (In all the mortality statistics of the Surgeon General's Office deaths occurring in men who had developed tuberculosis in Europe are charged to Europe, wherever the deaths may have actually taken place.) Deaths from pulmonary tuberculosis in 1919, officers and enlisted men, were, in the United States, 613; in Europe, 617. Of the deaths among enlisted men from pulmonary tuberculosis, 355 (a ratio of 1.27) occurred among white troops in the United States and 326 in Europe (ratio 0.67). Among the colored troops the deaths from pulmonary tuberculosis in the United States were 243 (ratio 4.15). In addition, 42 deaths occurred from pulmonary tuberculosis in Europe, in cases in which the color is not stated. The incidence of tuberculosis among the colored soldiers and their death rates from the disease are much higher than among white soldiers of the Army in the United States and Europe as a whole, but neither admissions nor deaths of colored troops differ materially from those of the white troops from the Southern States, from which part of the country the majority of the colored troops came.[49] In 1919, 674 deaths occurred from all tuberculosis, officers and men, in the United States, and 781 in Europe.[50] The type of disease in fatal cases of tuberculosis appeared to be more severe and acute in the later part of the war and after than in the early part. The total number of deaths from pulmonary tuberculosis in the Army from the beginning of the war up to January 1, 1920, was 2,240.

DETERMINATION OF LINE OF DUTY

Prior to the World War, when a case came up for discharge on account of physical disability, medical officers of the Army were expected to express their opinion as to whether or not the disability in question had been incurred in the line of duty; that is, whether it was or was not incident to the military service. This was to assist in determining whether or not the individual was entitled to a pension. The tendency of those who had to do with such matters was always to give the soldier the benefit of any reasonable doubt, it being understood, however, that if the medical officer was in possession of facts, such as the admission by the patient that the disease had existed prior to enlistment, or satisfactory proof submitted by reputable individuals to the same effect, the disability was not to be regarded as incurred in line of duty. But when the personal history was negative and the affection was of a chronic nature, particularly when it was chronic pulmonary tuberculosis, if the term of service before the disease was determined to be present was brief and there was a man-

ifest disproportion between the nature of the lesions (fibrous changes and the like) and the time within which they must have developed if first contracted after the patient had entered the military service, the disability was usually classed as not contracted in the line of duty. But even in such cases, if there was evidence of unusual exposure or of intercurrent disease which might reasonably be expected to have aggravated materially positively existing pulmonary disease, the disability was considered as incurred in the line of duty. Thus, a soldier was so classed, though of brief service and presenting evidence of extensive chronic pulmonary tuberculosis, who had been compelled to stand immersed deeply in sea water for 24 hours at the time of the Galveston flood, it being held that the excessive exposure to cold and the deprivation of food and drink for so long a period might be expected to materially aggravate his lung affection and therefore entitled the soldier to a pension. Infringement upon the rights of the individual in such matters was therefore always carefully guarded against; in fact there can be no doubt that many a man was granted a pension when there were good grounds for the belief that the disability in his case was of much longer standing than his military experience could account for.

Two views were held with regard to this matter. One was that, the soldier having submitted to the required physical examination and having been passed by the examiner, the Government was responsible for the character of the physical examinations and could not rightfully impugn the competence of its agent in claiming that he had erred, but was bound to abide by his decision that the individual at the time of his examination was free of disqualifying defects, so that any disability found at a later time was without question to be regarded as incident to the military service.[51] The other view was that, as the courts are understood to have ruled, the Government can not be made to suffer on account of the error of its agents; specifically in the present instance it might be put that it is unjust that the people should be taxed to pay a pension which was not deserved. The Government had the right, therefore, to investigate each case and decide on the evidence of whether or not the disability was pensionable. This latter view was the one generally adopted.

Circular No. 24, Surgeon General's Office dated September 11, 1917, was designed to furnish a standard for disability boards. It provided that, if in pulmonary tuberculosis the disability is detected in less than three months after the entrance of a man into the service, it will be regarded as not in line of duty unless of an acute type or unless the man had been subjected to extraordinary exposure or had had an aggravating intermittent disease. This circular, conflicting as it inevitably would, with the wishes of many individuals, encountered so much opposition that it was finally revoked and in the summer of 1918 a change was made in the Manual for the Medical Department to the effect that any soldier who shall have been accepted on his first physical examination after arrival at a military station as fit for service shall be considered to have contracted any subsequently determined physical disability in the line of duty unless such disability can be shown to be the result of his own carelessness, misconduct, or vicious habits, or unless the history of the case shows unmistakably that the disability existed before entrance of the soldier into the service.

By some medical officers "history" was understood to include the course of former pathological processes (particularly the evidence of fibrotic changes) as determined by the physical signs. It was held with regard to this point that while without doubt in many cases it can be assumed with practical certainty that the disease has existed for many years, at the same time it is not safe to give general permission to depend upon physical signs for the determination of the age of lesions, and the word "history" in the preceding paragraph should be considered to mean solely the personal recollection and such other data (recollections of relatives, of comrades, and the like) as may constitute the medical record of the past life of the individual in question. But though so much was conceded to the soldier by these orders, it was not enough, for several acts of Congress defined with increasing liberality the position of the Government toward the tuberculous individual, until at last it became the law that every commissioned officer, or enlisted man, or any other member of the military service who suffers a disability from disease contracted in line of duty shall be entitled to compensation, provided that the disease has not been caused by his own willful misconduct; that for the purpose of compensation all such persons shall be held to have been in sound condition when examined, accepted, and enrolled for service; and that these provisions shall be deemed to become effective as of April 6, 1917.[52]

The following data concern discharges for tuberculosis of enlisted men in the United States in 1917: In line of duty, 349; not in line of duty, 3,327.[53] That is, in the opinion of the medical officers most conversant with the facts, the number of soldiers who had incurred manifest tuberculous disease as the result of military service was to the number of those who had brought the disease with them into the Army approximately as 1 to 10. In reality it is probably considerably less than 1 in 10. It is out of place to comment upon this ratio here further than to call attention to the fact that the figures as to tuberculosis in our Army do not represent the incidence of the disease under the conditions of military service. Similarly a marked rise in the number of admissions for tuberculosis at a given camp is not to be interpreted as a sudden breaking down of large numbers of men under the conditions of military service nor as an acute epidemic of tuberculosis from recent infections but, rather, as due to the activities of an examining board which detected during its routine examinations the presence of tuberculous lesions in men who before the examination had for the most part been doing full military duty and in all probablity had not suspected that they were ill, such men being admitted to sick report for the better determination of their cases and as a preliminary to discharge. In some instances, however, local variations in individual commands or in special sections of the country present a more complicated problem.

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CHAPTER IV

CEREBROSPINAL MENINGITIS [a]

Cerebrospinal meningitis was of serious importance in the United States Army during the World War, not because of its incidence, which was comparatively low—in fact this disease ranked seventy-sixth as a cause for admission to hospital—but because of its high case mortality. Approximately 39 per cent of the cases died, thus causing meningitis to rank sixth as a cause of death. Furthermore, its appearance in a command usually caused a definite feeling of apprehension or alarm, and as a consequence few diseases were the cause of more concern to, or were given more active attention by, medical officers.

Many sporadic outbreaks and small epidemics have been reported throughout the world since 1805, when the disease was recognized clinically by Vieusseau. However, an accurate bacteriological diagnosis was not possible before 1887 when Weichselbaum[1] showed the meningococcus (*Diplococcus intracellularis meningitidis*) to be the specific cause of cerebrospinal meningitis.

This infection has, no doubt, occurred in our Army during all previous wars. Interesting clinical reports of outbreaks are recorded in histories of the War of 1812, the Mexican War, and Civil War; while it is evident from these reports that meningitis was present, the incidence is not known since there was considerable confusion in the nomenclature and differential diagnosis and, of course, bacteriological diagnostic methods were unknown. In spite of the fact that the meningococcus had been recognized as the specific cause of cerebrospinal meningitis for 10 years previous to the Spanish-American War, very few of the cases which occurred during that period were diagnosed by accurate laboratory methods, and clinically the disease was confused to some extent with typhoid, typhus, and other fevers. It is obviously impossible, therefore, to make a comparison of the meningitis rates of our Army for the World War with the rates for any previous war. Such a comparison not only would be worthless, but also misleading.

Since the Spanish-American War the diagnosis of cerebrospinal meningitis in the Army has been more exact, and the records have included only cases in which the clinical diagnosis was confirmed by bacteriological examination. During this time, as indicated graphically in Chart XXVI, the annual admission rate per 1,000 strength has been almost negligible, except during the mobilization of unseasoned troops; for example, the rate increased noticeably in 1907 at the time of the Cuban occupation, in 1913 during the mobilization on the Mexican border, and again in 1917 when the United States entered the World War. It is noteworthy that the concentration of Regular Army troops on the Mexican border in 1911 was not attended by any remarkable increase in the meningitis admission rate.

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

Cerebrospinal meningitis has for some time been known as a disease of soldiers, or a "barracks disease," because of its tendency to become more prevalent during the mobilization of recruits. These terms were justified by the increased incidence in the Army during the World War. The rapid mobilization of enormous numbers of untrained, unseasoned men, from all sections of the country, and their subsequent, intimate contact in large camps, provided ideal conditions for the dissemination of meningococci, and as a consequence meningitis was far more prevalent than in normal peace times.

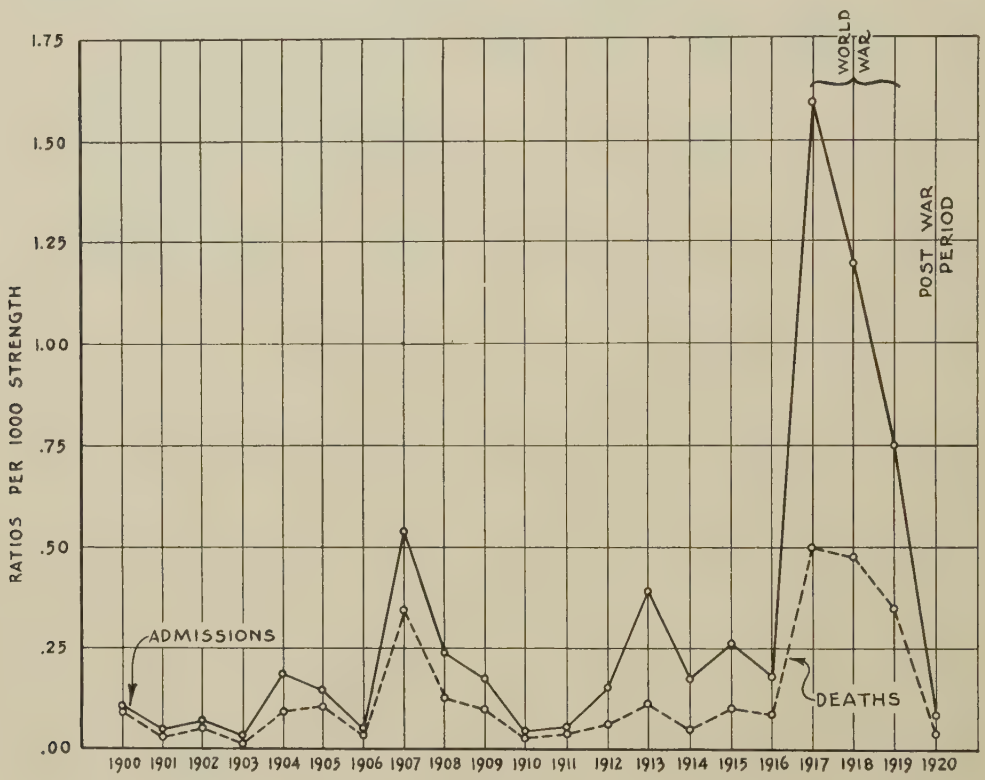

CHART XXVI.—Admissions and deaths for cerebrospinal meningitis, United States Army, 1900 to 1920. Ratios per 1,000 strength

STATISTICAL CONSIDERATIONS

The total mean annual strength of the Army for the period April 1, 1917, to December 31, 1919, was 4,128,479. As indicated in Table 28, 4,831 cases of cerebrospinal meningitis were reported as "primary admissions" during this period, giving an annual admission rate of 1.17 per 1,000 of strength, or 117 cases among every 100,000 men. Death occurred in 1,836 cases, or 38 per cent, giving an annual mortality rate of 0.44 per 1,000, or 44 deaths in 100,000 men.

TABLE 28.—*Cerebrospinal meningitis. Primary admissions and deaths shown by countries of occurrence for officers and enlisted men, United States Army, with ratios per 1,000 strength, April, 1917, to December 31, 1919*

Period, April, 1917, to December, 1919	Total mean annual strengths	Admissions		Deaths	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
Total officers and enlisted men, including native troops	4,128,479	4,831	1.17	1,836	0.44
Total officers and enlisted American troops	4,092,457	4,826	1.18	1,833	.45
Total officers	206,382	120	.58	56	.27
Total enlisted American troops:					
White	3,599,527	3,928	1.09	1,387	.39
Colored	286,548	526	1.84	239	.83
Color not stated		252		151	
Total	3,886,075	4,706	1.21	1,777	.46
Total native troops (enlisted)	36,022	5	.14	3	.08
Total Army in the United States (including Alaska):					
Officers	124,266	69	.56	28	.23
White enlisted	1,965,297	2,466	1.25	825	.42
Colored enlisted	145,826	343	2.35	133	.91
Total enlisted	2,111,123	2,809	1.33	958	.45
Total officers and men	2,235,389	2,878	1.29	986	.44
U. S. Army in Europe (excluding Russia):					
Officers	73,728	45	.61	23	.31
White enlisted	1,469,656	1,384	.94	534	.36
Colored enlisted	122,412	169	1.38	96	.78
Color not stated		250		149	
Total enlisted	1,592,068	1,803	1.13	779	.49
Total officers and men	1,665,796	1,848	1.11	802	.48
U. S. Army in Hawaii, total enlisted	19,480	3	.15	1	.05
U. S. Army in Panama, white enlisted	19,688	5	.25	1	.05
Other countries not stated, officers	8,388	6	.72	5	.60
Other countries not stated, total enlisted	14,232	22	1.55	7	.49
Transports:					
White enlisted	97,498	51	.52	22	.23
Colored enlisted	10,535	13	1.23	9	.85
Total	108,033	64	.59	31	.29
Natives troops enlisted:					
Philippine Scouts	18,576	1	.05	1	.05
Hawaiians	5,615	2	.36		
Porto Ricans	11,831	2	.17	2	.17

Only cases admitted to hospital primarily for cerebrospinal meningitis are considered in the figures given above or in the statistical tables used in this chapter. However, during this same period 1,008 additional cases and 443 deaths were reported as "concurrent diseases," having been admitted to hospital for other conditions. Therefore the total number of cerebrospinal meningitis cases was 5,839, an annual admission rate of 1.41 per 1,000 strength; while the total number of deaths was 2,279.

DISTRIBUTION BY GRADES

The incidence and mortality rates for enlisted men were greater than for commissioned officers. The annual admission rate among enlisted men with a total mean annual strength of 3,886,075 was 1.21 per 1,000, compared with a rate of 0.58 for officers, whose total mean annual strength was 206,382. The annual death rates per 1,000 were: Enlisted, 0.46; officers, 0.27.

The lower incidence and mortality rates among officers were no doubt due to several factors. As a rule the officers were older than the enlisted men and possibly less susceptible to the infection. They also had certain advantages, such as less crowded living quarters, less exposure to hardship and fatigue, and because of their training they were better able to understand and apply the principles of personal hygiene and sanitation.

RACIAL DISTRIBUTION

Meningitis was more common among colored than among white enlisted men. The annual admission rates per 1,000 strength were: Colored, 1.84; white, 1.09. The mortality rates were: Colored, 0.83; white, 0.39. The case fatality for colored troops was 42.7 per cent and for white troops, 35.3 per cent. A comparison of the rates in the United States is shown in Chart XXVII. It has long been known that the incidence is usually higher among colored persons. This apparent racial susceptibility may be due mainly to insanitary habits, ignorance, and carelessness in matters of elementary personal hygiene which, together with the necessarily crowded conditions of camp life, facilitate the spread of meningococci.

One case occurred among Philippine Scouts, 2 cases in Hawaiians, and 2 in Porto Ricans.

GEOGRAPHICAL DISTRIBUTION

In order of importance the geographical incidence was: The United States, Europe, Panama, Hawaii, Porto Rico, and the Philippine Islands. The slight difference between the rates for the United States and Europe probably has no significance, though it is possible that the lower incidence in Europe was influenced by the fact that overseas troops had become more hardened and resistant to infection because of their training, and a large percentage of meningococcus carriers were eliminated before the troops left the United States.

The slight importance of meningitis in the Tropics is emphasized by these figures.

IN THE UNITED STATES

During the World War, meningitis occurred most frequently in troops stationed in the United States. There were 2,878 primary admissions among American enlisted men in this country, an annual admission rate of 1.29 per 1,000 strength; death occurred in 986, or 34.1 per cent of the cases. The annual death rate was 0.44 per cent 1,000 strength; 131 patients were discharged for disability, a rate of 0.06 per 1,000. A total of 150,386 days were lost because of the disease. The admission and death rates for colored troops were higher than for white, as shown in Chart XXVII.

CEREBROSPINAL MENINGITIS, COMP. RATES

WHITE & COLORED ENL. MEN-UNITED STATES

APRIL, 1917 – DEC., 1919

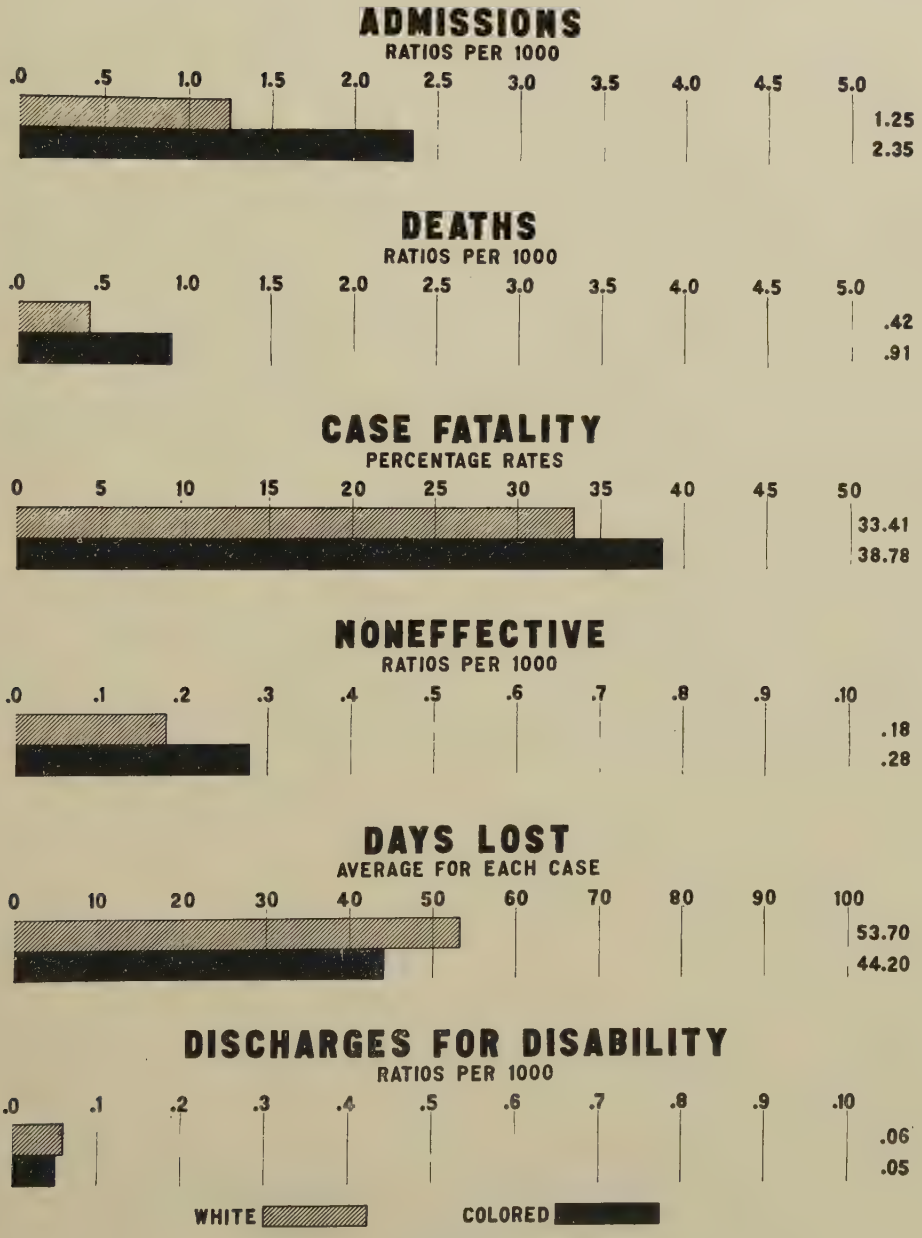

CHART XXVII

TABLE 29.—*Cerebrospinal meningitis. Primary admissions and deaths, by months, with annual ratios per 1,000 strength; white and colored enlisted men, United States Army in the United States and Europe, April, 1917, to December, 1919*

Month and year	White enlisted men								
	United States					Europe			
	Mean strength	Admissions		Deaths		Mean strength	Admissions		Deaths	
		Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000		Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000
1917										
April	183,758	18	1.18	9	0.59					
May	245,454	35	1.71	20	.98	626				
June	309,205	22	.85	9	.35	12,794	1	0.89		
July	458,817	22	.58	8	.21	28,821	5	2.08		
August	562,714	15	.32	7	.15	50,882	2	.47		
September	776,466	10	.15	5	.08	70,266	4	.68	1	0.17
October	1,032,244	93	1.08	19	.22	92,139	2	.26	2	.26
November	1,061,422	273	3.09	102	1.15	123,429	14	1.36	3	.29
December	1,129,065	371	3.94	149	1.58	160,178	35	2.62	19	1.42
1918										
January	1,096,434	409	4.48	131	1.43	193,264	54	3.35	15	.93
February	1,095,039	222	2.43	68	.75	223,130	25	1.34	9	.48
March	1,129,223	142	1.51	39	.41	283,268	40	1.69	9	.38
April	1,168,558	122	1.25	43	.44	388,048	31	.96	11	.34
May	1,197,757	83	.83	17	.17	587,240	33	.67	7	.14
June	1,303,746	74	.68	15	.14	796,427	42	.63	7	.11
July	1,328,513	61	.55	10	.09	1,063,192	21	.24	5	.06
August	1,284,247	30	.28	7	.07	1,266,592	35	.33	18	.17
September	1,321,440	41	.37	20	.18	1,527,793	78	.61	41	.32
October	1,343,933	136	1.21	51	.46	1,635,321	197	1.45	88	.65
November	1,255,195	70	.67	22	.21	1,682,836	141	1.01	56	.40
December	941,219	63	.80	27	.34	1,591,962	180	1.36	65	.49
1919										
January	672,937	45	.80	11	.20	1,488,683	122	.98	53	.43
February	471,815	26	.66	12	.31	1,310,083	108	.99	43	.39
March	406,839	17	.50	5	.15	1,115,693	81	.87	37	.40
April	339,836	21	.74	6	.21	853,425	63	.89	23	.32
May	291,810	17	.70	4	.16	569,842	23	.48	10	.21
June	246,903	9	.44	1	.05	271,633	10	.44	4	.18
July	215,104	7	.39	3	.17	111,634	10	1.07	3	.32
August	156,791	5	.38	2	.15	48,006	5	1.25	1	.25
September	149,360	2	.17			30,315	4	1.58	1	.40
October	139,877	1	.09			21,055	9	5.13		
November	132,403	1	.09	1	.09	18,920	1	.63	1	.63
December	135,441	1	.09	1	.09	18,379				
Month not stated		2		1			8		2	
Total	1,965,297	2,466	1.25	825	.42	1,469,656	1,384	.94	534	.36

TABLE 29.—*Cerebrospinal meningitis. Primary admissions and deaths, by months, with annual ratios per 1,000 strength; white and colored enlisted men, United States Army in the United States and Europe, April, 1917, to December, 1919*—Continued

Month and year	Colored enlisted men								
	United States					Europe			
	Mean strength	Admissions		Deaths		Mean strength	Admissions		Deaths	
		Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000		Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000
1917										
April	4,870									
May	5,826									
June	5,171									
July	6,675									
August	8,519									
September	9,409									
October	21,795					935				
November	39,225	16	4.89	6	1.84	2,392	1	5.03	1	5.03
December	36,851	38	12.37	15	4.88	5,346	2	4.48	1	2.24
1918										
January	50,705	30	7.10	12	2.84	8,673	5	6.92	1	1.38
February	49,955	11	2.64	3	.72	9,664	2	2.48		
March	54,814	22	4.82	9	1.97	11,541	3	3.12	1	1.04
April	59,015	21	4.27	12	2.44	12,667				
May	87,650	51	6.98	17	2.33	28,279	4	1.70	4	1.70
June	89,305	24	3.23	6	.81	33,208	2	.72		
July	124,976	17	1.63	6	.58	47,171	2	.51		
August	168,422	8	.57	6	.43	78,734	8	1.22	4	.61
September	164,846	15	1.10	3	.22	91,270	14	1.84	7	.92
October	182,705	39	2.56	10	.66	138,827	25	2.16	16	1.38
November	150,587	19	1.51	8	.64	148,697	20	1.61	13	1.05
December	104,140	10	1.15	8	.92	148,372	20	1.62	11	.90
1919										
January	68,337	3	.53	1	.18	140,396	16	1.37	7	.60
February	66,104	11	2.00	7	1.27	131,219	11	1.01	6	.55
March	44,634	7	1.88	3	.81	123,152	9	.88	4	.39
April	29,824	1	.40	1	.40	119,801	10	1.00	9	.90
May	20,780					108,650	7	.77	4	.44
June	18,562					64,166	6	1.12	5	.94
July	20,058					12,508	1	.96	1	.96
August	18,013					1,741				
September	11,322					1,287				
October	9,084					185				
November	8,792					83				
December	8,935									
Month not stated							1		1	
Total	145,826	343	2.35	133	.91	122,412	169	1.38	96	.78

Cerebrospinal meningitis, as indicated by the weekly reports of the United States Public Health Service and the United States mortality statistics, had been prevalent and widely distributed throughout the civilian population of the United States for several years before we entered the World War. The rapid mobilization of over a million men from all sections of the country between April and October, 1917, naturally brought the disease into every cantonment, and the monthly admission rates increased to a peak of over 4 per 1,000 in January, 1918. From this point the rate fell to about 0. 3 in August, and again rose to a second peak of less than 2 per 1,000 in October, 1918. Then, instead of rising during the winter of 1918, the rates decreased after the armistice began, until a low point of .09 was reached in October, November, and December, 1919, as shown in Table 29 and graphically by absolute numbers in Chart XXVIII. Evidently the incidence was affected not so much by temperature or season as by mobilization.

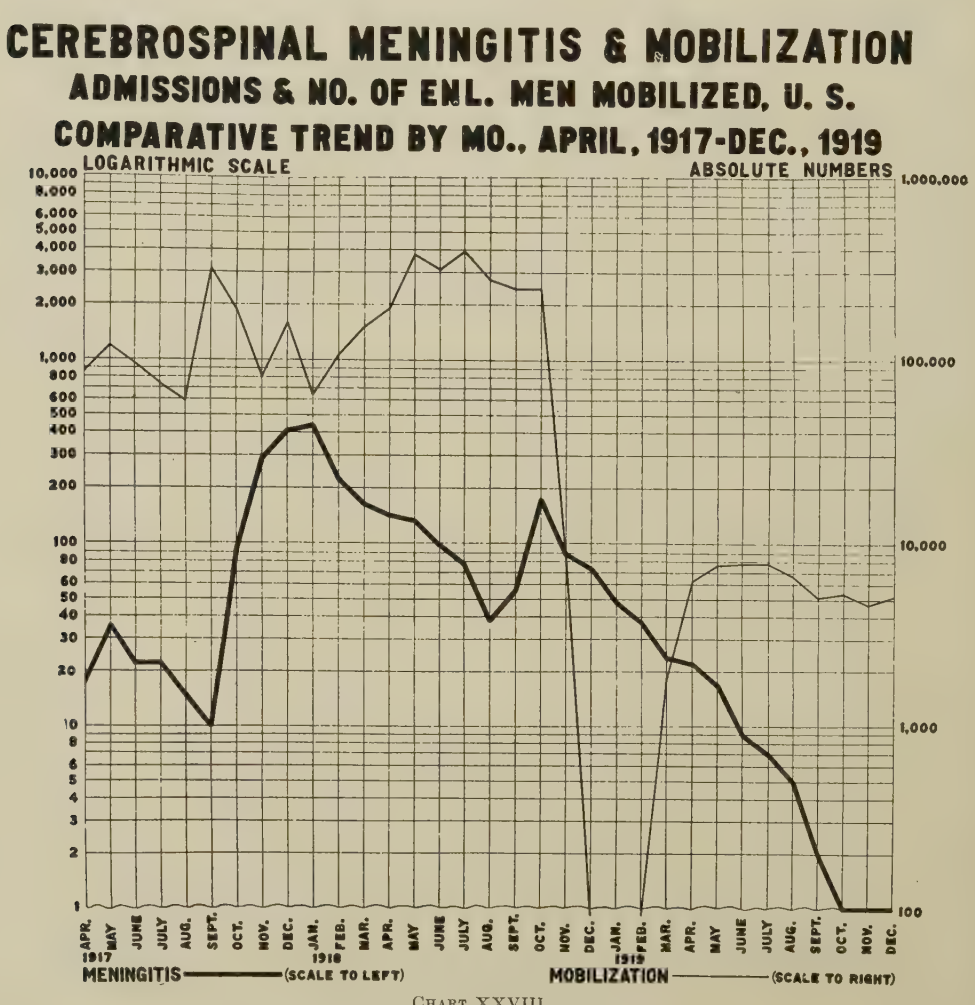

CHART XXVIII

Since a majority of the men were collected in 39 large camps located in various sections of the country, the occurrence of meningitis in these camps, shown in Table 30 and Chart XXIX, is of interest.

The highest primary admission rates for white and colored enlisted men combined occurred in Camps Jackson, S. C. (6.76 per 1,000), Beauregard, La. (6.40), and Funston, Kans. (2.72); and the numbers of cases in these camps were, respectively, 284, 132, and 153, or one-fifth the total number for the whole

TABLE 30.—*Cerebrospinal meningitis. By camps of occurrence, showing primary admissions and deaths, with annual ratios per 1,000 strength, white and colored enlisted men, United States Army; also case fatality rates, April, 1917, to December, 1919*

Camps	White enlisted men				Colored enlisted men				Total enlisted men				Case fatality rates (per cent)
	Admissions		Deaths		Admissions		Deaths		Admissions		Deaths		
	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	
Beauregard, La	130	6.43	58	2.87	2	4.74			132	6.40	58	2.81	43.9
Bowie, Tex	52	2.06	15	.59	2	2.10	2	2.10	54	2.06	17	.65	31.4
Cody, N. Mex	19	.84	5	.22					19	.84	5	.22	26.3
Custer, Mich	22	.61	8	.22					22	.61	8	.21	36.3
Devens, Mass	40	.88	13	.28	8	3.60	3	1.35	48	1.00	16	.34	33.3
Dix, N. J	24	.53	8	.18	4	.83	3	.62	28	.56	11	.22	39.2
Dodge, Iowa	35	1.05	8	.24	26	4.48	11	1.89	61	1.56	19	.49	31.1
Doniphan, Okla	66	2.47	21	.79					66	2.47	21	.79	31.8
Eustis, Va	2	.32			1	2.19			3	.44			
Fremont, Calif	7	.45							7	.45			
Funston, Kans	131	2.62	33	.66	22	3.57	6	.97	153	2.72	39	.69	25.4
Gordon, Ga	49	1.29	16	.42	27	3.96	13	1.91	76	1.69	29	.65	38.1
Grant, Ill	20	.47	5	.12	13	1.87	9	1.30	33	.67	14	.28	42.4
Greene, N. C	62	2.37	20	.76	9	2.55	2	.57	71	2.38	22	.74	30.9
Greenleaf, Ga	6	.50	2	.17					6	.50	2	.17	33.3
Hancock, Ga	38	1.04	10	.27	5	3.13	2	1.25	43	1.13	12	.32	27.1
Humphreys, Va	6	.62	1	.10	8	2.59	4	1.30	14	1.06	5	.39	35.7
Jackson, S. C	244	6.62	71	1.93	40	7.80	13	2.53	284	6.76	84	1.99	29.5
Johnston, Fla	21	1.06	3	.15					21	.94	3	.15	14.2
Kearny, Calif	36	1.41	7	.27					36	1.41	7	.27	19.4
Lee, Va	52	1.02	16	.31	5	.75			57	.99	16	.28	28.07
Lewis, Wash	67	1.42	20	.42					67	1.40	20	.42	29.85
Logan, Tex	20	.75	8	.30					20	.73	8	.30	40.0
MacArthur, Tex	23	.95	2	.08					23	.91	2	.08	8.7
McClellan, Ala	29	1.09	7	.26	9	4.23	2	.94	38	1.32	9	.32	23.2
Meade, Md	57	1.36	20	.48	8	.99	3	.37	65	1.29	23	.46	35.3
Mills, N. Y	38	1.66	6	.26	3	2.39	2	1.59	41	1.69	8	.33	19.5
Pike, Ark	82	2.01	36	.88	16	1.84	5	.57	98	1.98	41	.83	41.8
Sevier, S. C	55	2.10	19	.73	13	8.10	3	1.87	68	2.45	22	.79	32.3
Shelby, Miss	46	1.60	13	.45	1	.61			47	1.54	13	.45	27.6
Sheridan, Ala	12	.47	5	.20	1	1.13			13	.49	5	.20	38.4
Sherman, Ohio	36	.97	6	.16	7	1.21	1	.17	43	1.01	7	.17	16.2
Taylor, Ky	73	1.71	30	.70	2	.46			75	1.60	30	.64	40.0
Travis, Tex	49	1.31	18	.48	7	1.06	5	.76	56	1.27	23	.52	41.07
Upton, Long Island, N. Y	22	.55	13	.32	5	1.07	4	.86	27	.60	17	.37	62.9
Wadsworth, S. C	17	.56	6	.20	3	1.79	2	1.20	20	.63	8	.25	40.0
Wheeler, Ga	40	1.67	22	.92	7	3.86	2	1.10	47	1.83	24	.95	51.06
Others					2	5.90			2	5.90			
Total	1,728	1.49	551	.48	256	2.31	97	.88	1,984	1.56	648	.51	32.7

country. It is obvious that the increased prevalence was not due entirely to the size of these camps, since other large camps such as Camp Dix, N. J., had much lower admission rates; furthermore, it can not be ascribed to climate or other similar local conditions, since the rates for different camps in a single State, or for different States in a given section of the country, varied considerably. For example, in South Carolina the primary admission rates per 1,000 were 6.76 for Camp Jackson, 2.45 for Camp Sevier, and only 0.63 for Camp

CEREBROSPINAL MENINGITIS, BY CAMPS
ADMISSIONS, WHITE ENLISTED MEN, U. S.
APRIL, 1917–DEC., 1919

RATIOS PER 1000

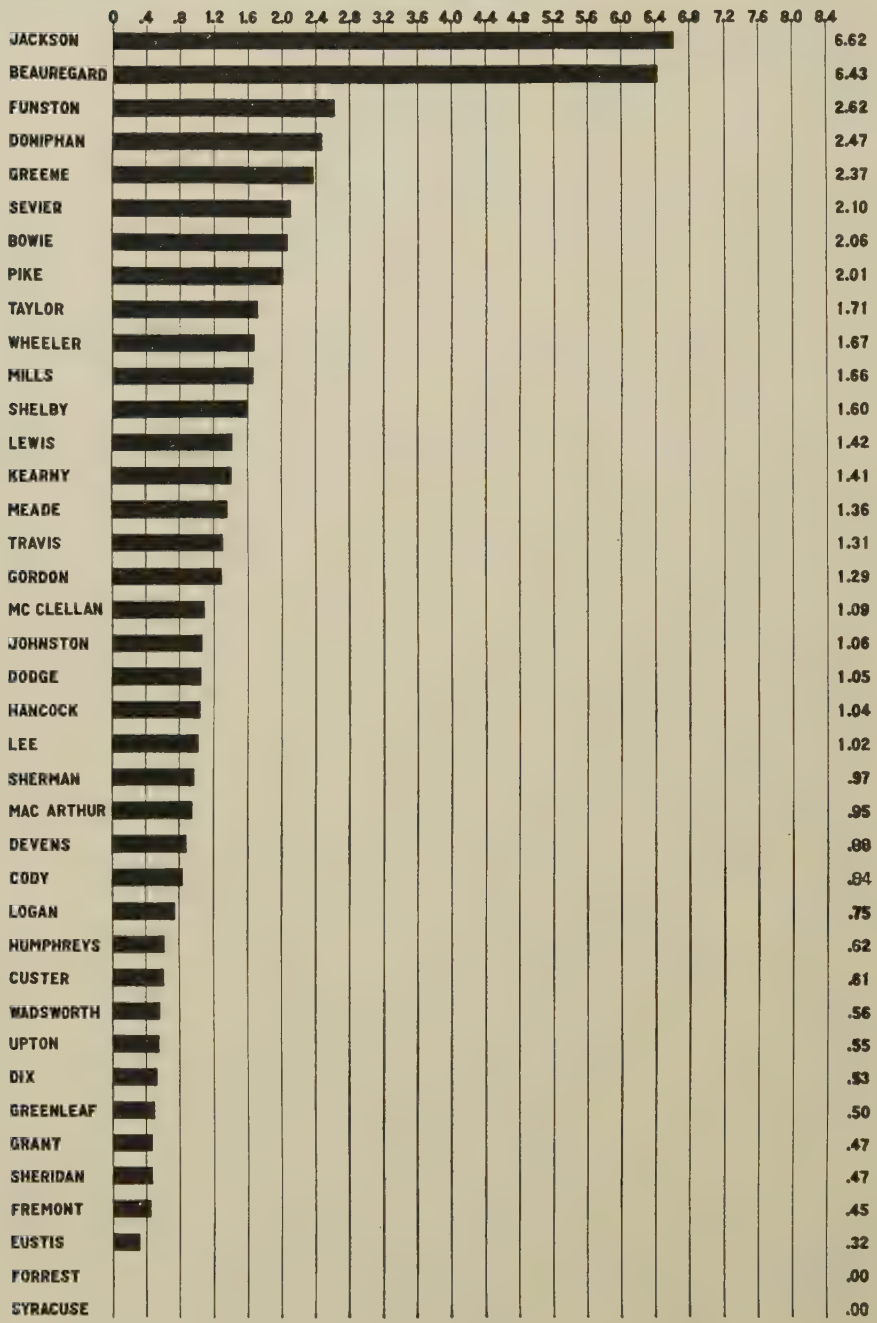

CHART XXIX

Wadsworth. A study of the mobilization charts indicates that the disease was most common in the camps which were made up mainly of men from the rural sections of the Southeastern States and from Kansas and Missouri, and that it was relatively infrequent in camps composed of troops drawn from States which had large urban populations.

Sporadic cases occurred in all of the other camps except Camp Forrest in Georgia, and Camp Syracuse in New York, which were relatively small camps, organized late in 1918.

The relatively high incidence of meningitis in certain of our camps was no doubt due mainly to the fact that large numbers of susceptible men from rural sections, under the strain and fatigue incident to intensive military training, were, for the first time, brought into close contact with meningococcus carriers and cases.

Camp Jackson, S. C.

This National Army cantonment which had 284 cases of meningitis and an admission rate of 6.76 per 1,000, drew a large percentage of its men from the rural sections of North Carolina, South Carolina, and Florida.[2] Meningitis occurred in practically epidemic form during November and December, 1917, and was prevalent from that time on.

Camp Wadsworth, S. C.

Although located in South Carolina, only 20 cases occurred in this camp, and the admission rate was 0.63 per 1,000 strength. However, Camp Wadsworth was made up largely of troops from New York City and other thickly populated localities.[3]

Camp Beauregard, La.

There were 132 cases, an annual primary admission rate of 6.40 per 1,000 in this camp, which drew troops mainly from Louisiana, Arkansas, and Mississippi,[4] all of which States have a large rural population.

Camp Funston, Kans.

Including all troops in the State, 153 cases, or an admission rate of 2.72 per 1,000, were reported for Camp Funston. The men in this camp came mainly from Missouri and Kansas.[5]

IN EUROPE

Meningitis in the American Expeditionary Forces occurred sporadically rather than in extensive epidemics. A large percentage of the cases originated either in the base ports or on shipboard, and, as a rule, the incidence was highest in organizations from training camps with high rates in the United States.

There were 1,848 primary admissions reported between June 1, 1917, and December 31, 1919, an annual admission rate of 1.11 per 1,000 strength, or 111 cases in every 100,000 men. Of these, 802 died, a case fatality of 43.3 per cent; the annual death rate was 0.48 per 1,000 strength. The first case was reported in June, 1917, and more cases occurred as the strength of the Army increased during the following months, until a peak was reached in January, 1918, with 59 cases and a rate of over 4 per 1,000. These cases were mainly due to outbreaks in organizations which had brought the infection with them from their training camps in the United States.

In October, 1918, when the strength was over a million and a half men, 222 cases occurred, or a rate of less than 2 per 1,000. This increase occurred just after the highest incidence of influenza, which possibly contributed, along with hardships, fatigue, and overcrowding of troops, to lowering the resistance of soldiers to meningitis. During demobilization the monthly number of cases decreased rapidly until there were only 9 in October, 1 in November, and none in December, 1919. The high admission rate of 5 per 1,000 in October, 1919, is not considered significant, as it is based on only 9 cases.

ETIOLOGY

While the experience during the World War added nothing entirely new to our knowledge of the etiology of cerebrospinal meningitis, it emphasized the relative importance of certain contributing factors.

As stated above, since 1887 it has been known that the disease is a specific infection caused by the meningococcus. In 1909 Dopter[6] differentiated two types of meningococci which he designated "normal" and "para." Gordon[7] divided meningococci isolated from cases of meningitis, which occurred in British troops during the World War, into four serological types, which he called I, II, III, and IV. His types I and II corresponded with Dopter's "para" and "normal" types, while III and IV were irregular or intermediate in their serological reactions. The relative frequency of these types in the British Army is indicated by the following table:[8]

Type	I	II	III	IV
Specimens	195	218	69	36
Percentage	37.66	44.05	11.38	6.94

In 1917, Flexner[9] investigated the subject and agreed with Dopter by dividing the meningococci into normal, para, and intermediate types.

In the United States Army the typing of meningococci was not a routine procedure; however, it was done in a great many instances. The information obtained sometimes aided in the selection of therapeutic serum for individual cases or in tracing the relationship between cases or carriers. The reports from certain organizations indicate that the normal type (II) predominated; that the para type (I) was about half as frequent, and that a relatively small percentage of the intermediate types (III and IV) were found.

It is now generally believed that the normal habitat of the meningococcus is the posterior nasopharynx of man. In susceptible individuals the organism may invade the body and produce meningitis, while in resistant or immune persons infection does not occur. These latter, apparently normal "carriers," may harbor meningococci in their throats for long periods of time and spread them to their associates. While it has been estimated that about 1 to 3 per cent of the population are carriers, fortunately relatively few persons are susceptible to the infection. Conditions which increase the contact between carriers and susceptible individuals favor the spread of meningitis. The tendency of the disease to greater prevalence in the winter and early spring is, no doubt, due to the fact that people live indoors and are therefore closer together

during the cold months. The higher incidence among recruits, especially those from rural localities, in mobilization camps points to the importance of contact between these relatively susceptible persons and carriers. Other infections, fatigue, and hardship may also help to lower the resistance of soldiers.

DIAGNOSIS

The specific diagnosis of cerebrospinal meningitis depends upon the isolation and identification of the meningococcus from the cerebrospinal fluid. During the World War, spinal punctures usually were performed on all patients with symptoms of meningeal irritation or inflammation; and the diagnosis was based entirely on the bacteriological examination of the spinal fluid. Wegeforth and Latham,[10] however, warned against the indiscriminate use of spinal puncture as a diagnostic procedure in human septicemia, stating that the release of spinal fluid was an important factor in the development of meningitis. This observation was preceded by the investigations of Weed, Wegeforth, Ayer, and Felton,[11] who showed that in animals suffering with an experimentally produced bacteriemia, spinal puncture was invariably followed by meningitis. It was therefore recommended that careful consideration be given to the bacteriological study of the blood before attempting puncture of the spinal canal. However, in spite of the fact that cases were observed in which the spinal fluid obtained at the first puncture was sterile and from later punctures infected, this was usually considered only an indication of the normal progress of the infection; and it was quite generally believed that diagnostic spinal puncture in meningitis was not attended by any serious results.

The observations of previous workers that meningococci may invade the blood stream were confirmed during the World War by Herrick.[12] He reported that in a comparatively large percentage of the cases at Camp Jackson, S. C., the organism was isolated in cultures made of the blood before the appearance of meningeal symptoms; and, as a consequence, he advocated the more general use of blood cultures as an aid to early diagnosis, and proposed that the term "meningococcus sepsis" be used.

In most cases it is possible to isolate the meningococcus from the upper respiratory tract, and nasopharyngeal cultures may be helpful, when meningococci in a turbid spinal fluid escape detection. During the World War nasopharyngeal cultures were used mainly in the detection of carriers, but occasionally as an aid in the diagnosis of cases.

The symptomatology of cerebrospinal meningitis observed during the World War did not differ materially from that already recognized as characteristic of the disease. Naturally, differences occurred in the percentage of severe and mild cases in the various camps, resulting in variations in the predominant clinical signs and symptoms.

TREATMENT

Polyvalent antimeningococcic serum was used routinely for treatment. The gross case fatality for primary admissions in the whole Army was about 38 per cent. In the American Expeditionary Forces about 43 per cent of the cases died, while in the United States the percentage was about 34. Also the

case fatality in different camps in this country varied from 8 to 43.9 per cent, as shown in Table 30. These differences no doubt were influenced to some extent by differences in the severity of the disease in various localities, but the most important factor was probably the duration of the disease before serum therapy was begun.

According to Flexner [9] and others, specific serum treatment reduced the mortality due to meningitis from a percentage of 60 to 90 to a gross case mortality of 23 to 50 per cent, and even to a much smaller percentage when the serum was administered in the first three days of the disease.

	Flexner	Netter	Dopter	Christomanos	Levy	Flack
Number of cases	1,294	100	402	186	165	43
Treatment begun—	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Before third day	18.1	7.1	8.2	13.0	13.2	9.09
From fourth to seventh day	27.2	11.1	14.4	25.9	20.4	
After seventh day	36.5	23.5	24.1	47.0	28.6	50.

The polyvalent immune serum used in the Army was supplied principally by the Rockefeller Institute, the New York City Board of Health, and three commercial laboratories.[13] As a rule, from 30 to 80 strains of meningococci, representing different proportions of the various types, were employed in its preparation. In France, additional serum was obtained from the Pasteur Institute.[14]

In individual cases, considerable differences were observed in the therapeutic results obtained with different sera, and occasionally cases which were not improved by one serum were promptly benefited by another. In some of these instances the first serum used may have been generally lacking in antibody content, but usually the therapeutic failure occurred because the serum had been prepared with a large proportion of meningococcus strains which were different from the type causing the disease. In the treatment of 13 cases at Camp MacArthur, Tex., by Medalia [15] it was concluded from the therapeutic results and agglutination tests that one serum which they used was more effective than another because it contained specific antibodies for the particular strains of meningococci causing their infections. Robison and Gerstley [16] reported that they found an American serum to be practically useless in the treatment of meningitis in Coblenz, Germany, while almost 100 per cent of the cases treated with French serum recovered. They thought that possibly the American serum failed because strains of meningococci, similar to those encountered in Germany, were not used in its manufacture. Because of these differences, sera from several sources were usually kept available for use in the large hospitals.

Since the value of serum is greatest when given early in the disease, every effort was made to avoid delay in its administration. Usually doses of from 30 to 60 c. c. were injected intraspinally immediately following diagnostic lumbar puncture and drainage of the spinal fluid. If bacteriological examination showed meningococci in the fluid, the dose was repeated in 12 hours, and then daily, depending upon the condition of the patient. In the more severe cases, usually 6 to 10 injections were given. The therapeutic results obtained by

this method in different camps varied considerably, as is indicated by the case-fatality percentages. This was no doubt due to a number of factors; such as differences in the severity of infections, differences in the types of infecting meningococci, and variations in the time and methods of treatment.

While as a general rule serum was administered by the intraspinal route alone, in certain camps, including Camp Jackson, Camp Funston, and Camp Beauregard, intravenous injections were used in addition to the intraspinal therapy in a number of the cases. A comparison of the results obtained by the intraspinal method and the combined intraspinal and intravenous method of treatment at Camp Jackson was reported by Herrick,[12] as follows:

	Entire epidemic		Cases treated by intraspinal route		Cases treated by intraspinal and intravenous routes	
Number of cases	265		137		128	
	Number	Per cent [a]	Number	Per cent [a]	Number	Per cent [a]
Deaths	66	24.8	47	34.3	19	14.8
Mild cases	97	3.0				
Early diagnosis	59	3.3	41	2.4	18	5.5
Late diagnosis	38	2.5	26		12	8.3
Severe cases	168	37.4				
Early diagnosis	46	34.7	20	70	26	7.6
Late diagnosis	122	38.5	50	64	72	20.8

[a] Percentages are mortality rates.

At Camp Beauregard, where the gross case mortality was 43.9 per cent, Landry and Hamley [17] reported that whereas the mortality was 54.2 per cent in 86 cases given only intraspinal injections, and was 55.5 per cent in 9 cases given intraspinal injections followed late in the disease by intravenous injections, in 34 cases treated on admission by the combined method the mortality was 32.3 per cent. Again, the mortality among 191 Camp Funston cases, treated intraspinally, was 28.8 per cent; Stone and Truitt [18] reported a mortality of 28.1 per cent in 32 cases treated by the combined intraspinal and intravenous method. Bigelow [19] reported that 70 per cent of 10 cases treated intraspinally at a hospital center in France died; while the mortality was 62.5 per cent in 8 cases given the combined treatment. The usual nonspecific symptomatic treatment was used, of course, in all cases.

Cases of recurrent meningitis were treated, as a rule, in the same way as were primary infections.

Serum sickness occasionally followed the serum treatment in meningitis, but no cases of anaphylaxis occurred.

COMPLICATIONS, SEQUELÆ, AND CONCURRENT DISEASES

Complications or sequelæ of various kinds occurred in more than one-third of the 4,831 cases admitted to hospital primarily for cerebrospinal meningitis; however, the case fatality was only 32.3 per cent among these complicated cases, while the fatality among the uncomplicated cases was 41.1 per cent.

Some of the more important complications and sequelæ which were reported are shown in the following table:

Disease	Cases	Deaths	Case mortality	Disease	Cases	Deaths	Case mortality
			Per cent				*Per cent*
Arthritis	79	6	7.6	Mastoiditis	39	27	69.2
Ankylosis	7	0	0	Nephritis:			
Apoplexy	5	2	40	Acute	14	7	50
Bronchitis	62	27	43.5	Chronic	14	5	35.7
Cardiac dilatation	3	3	100	Neuritis	28	0	0
Cystitis	8	4	50	Neuralgia	4	0	0
Conjunctivitis	6	0	0	Otitis media	100	42	42
Choroiditis	4	1	25	Pericarditis	13	4	30.7
Endocarditis, acute	13	5	38.4	Pleurisy:			
Erysipelas	17	7	41.1	Suppurative	12	8	66.6
Epididymitis (nonvenereal)	9	0	0	Serofibrinous	6	5	83.3
Neuroses, functional	27	1	37	Paralysis:			
Hemorrhage	1	1	100	Facial	4	0	0
Hearing, defective	29	0	0	No cause stated	50	2	4
Iritis	3	0	0	Paraplegia	6	0	0
Laryngitis	2	2	100	Pneumonia:			
Myocardial insufficiency	15	3	20	Lobar	120	92	76.6
				Bronchial	144	117	81.2

It will be noted that the mortality of meningitis, complicated by pneumonia, was especially high.

The records of the Surgeon General's Office show that in the Army during the World War the following concurrent diseases occurred in cases of cerebrospinal meningitis:

Disease	Cases	Deaths	Case mortality	Disease	Cases	Deaths	Case mortality
			Per cent				*Per cent*
Acute articular rheumatism	12	5	41.6	Measles	32	17	53.1
Diphtheria	9	1	11.1	Mumps	68	7	10.2
Influenza	67	24	35.8	Scarlet fever	8	1	12.5

The same records show also the occurrence of cerebrospinal meningitis as a concurrent disease in patients already suffering with the following diseases:

Disease	Cases	Deaths	Case mortality	Disease	Cases	Deaths	Case mortality
			Per cent				*Per cent*
Measles	93	37	39.7	Bronchitis	24	4	16.6
Influenza	542	256	47.2	Pneumonia:			
Mumps	35	10	28.5	Lobar	60	44	73.3
Otitis media	23	14	60.8	Bronchial	65	31	47.6

PREVENTION

The measures employed to prevent meningitis in the Army during the World War can not be considered as altogether successful. In spite of the great care exercised in the isolation of cases, wholesale examinations made to detect and eliminate carriers of meningococci, and the various other methods employed to limit the spread of the disease, the incidence of meningitis in troops was much greater than in the civilian population. These experiences, however, were of value, as they helped to crystallize scientific opinion concerning the relative practical value of the different preventive methods tried.

Since the meningococcus, a delicate organism which dies quickly outside the body, is probably disseminated only by human cases or carriers, most of the methods used for controlling meningitis aimed at the prevention of contact between persons harboring the organism and normal individuals.

All meningitis patients were given specific and general treatment and were carefully isolated until disposed of, or until their secretions became free of meningococci, thus minimizing the danger of secondary contact infections during the course of the disease and eliminating the menace of "convalescent carriers." The special precautions observed varied; in some instances patients were isolated in separate rooms, but usually they were kept in isolation wards in which the beds were separated by sheets arranged to form cubicles. As a rule gowns were worn by the attendants and often gauze face masks were used by attendants, patients, or both. Antiseptic solutions of various kinds were used extensively for the disinfection of the hands and the upper respiratory secretions, and occasionally were employed as gargles or nasal sprays by attendants and patients.

The experience in the Army and in civil communities indicates that healthy individuals rarely contracted meningitis from patients having the disease. Usually, it was very difficult to trace the infection from any patient to a preceding one. This was no doubt largely due to the great care with which patients were isolated during treatment.

Whenever a case of meningitis occurred, all persons who had been closely associated with the patient were isolated, and nasopharyngeal cultures were made and examined for meningococci. Usually several individuals known as "contact carriers" were found who, although they showed no evidence of meningitis, harbored meningococci in the mucous membranes of the nose or throat. The percentage of carriers among contacts was greater than among noncontacts, and in the former group the percentage was highest among those most intimately associated with the patient.

Contact carriers were isolated until their nasopharyngeal cultures indicated that they were free from meningococci. Various antiseptics and antimeningococcus sera were used locally, and vaccines were administered subcutaneously in attempts to eradicate meningococci from the upper respiratory tract. The results of such treatment were not of obvious value, but fortunately the carrier state in contacts was usually temporary and even without treatment over two-thirds of them cleared up in a short time. Many observers thought that, except in carriers with diseased tonsils, sinuses, or pharynx where surgical removal of the focus was indicated, it was best to rely chiefly on exercise, fresh air, and sunlight for treatment of the carrier state.

Incubationary carriers or persons in the incubation stage of meningitis were rarely identified by nasopharyngeal cultures before clinical signs of the disease became manifest. When detected, they were isolated, of course, and given the usual specific and general treatment.

Extensive carrier surveys made in many of the camps showed that from 1 to 3 per cent of apparently normal individuals, who presumably had not been associated with meningitis cases, harbored meningococci in the upper respiratory tract. These persons were called "casual" or "noncontact carriers."

In some of the camps where meningitis was especially prevalent meningococcus carriers were reported as follows: At Camp Funston, Shorer[20] found 3.22 per cent in 102,179 nasopharyngeal cultures; while Stone and Truitt[18] reported 2.1 per cent in 196,000 cultures; and according to Baeslock,[21] 2.6 per cent carriers were identified in 19,178 cultures at Camp Jackson. An unusually large proportion of carriers, 9.1 per cent, was reported by Robey[22] in 10,076 cultures at Camp McClellan, where meningitis occurred relatively infrequently. Lamb[23] found 1.28 per cent in 20,208 cultures at Camp Cody, while at Camp Lewis 1.4 per cent carriers were reported in 18,998 cultures.

The isolation and treatment of these large numbers of meningococcus carriers proved to be a very difficult problem. They were kept in special wards, hospitals, or in segregation camps. Many antiseptics, including dichloramine-T, tincture of iodine, silver nitrate solution, and others were used locally in the nose and throat. The injection of meningococcus vaccines or local applications of serum apparently had no specific effect upon meningococci in the respiratory passages. Although some observers claimed that certain antiseptics were effective, it can be stated that no generally satisfactory specific cure for the carrier state was found. Apparently, outdoor exercise and exposure to sunshine was about as effective as the use of drugs in the treatment of meningococcus carriers.

The results of attempts to immunize normal individuals against meningococcus infections by means of specific vaccines were inconclusive.

Theoretically, it should be possible to prevent the occurrence of meningitis by the isolation of all cases and carriers, but the experience of the World War demonstrated the futility of such a course in large, active military organizations. As a result, during the latter part of the war it was considered advisable to limit isolation and treatment to actual cases of meningitis and contact carriers and to attempt to keep down infection by paying particular attention to the improvement of the general living conditions.

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CHAPTER V

ANTHRAX [a]

STATISTICAL CONSIDERATIONS

Table 31 shows 149 primary admissions for the total Army during the World War, giving an admission ratio of 0.04 per 1,000 strength. Officers and enlisted men, American troops, contributed 148 of these primary admissions, 2 of which were among officers, 123 among white enlisted men, and 6 among colored enlisted men. One case was reported among native troops. There were reported 22 deaths for the total Army among the primary admissions. All of these deaths were among American troops, 19 among white enlisted, 1 among colored enlisted, and 2 among enlisted men whose color was not stated. The case mortality was 14.8 per cent.

Anthrax was more common in the Army serving in the United States than in Europe. There were 94 primary admissions among white troops and 6 among colored troops serving in the United States. There were 14 deaths among the former and 1 among the latter.

About one-sixth of the total number of primary admissions for anthrax in the United States Army occurred among white enlisted men serving in Europe. There were 26 such admissions. (Table 31.) The admissions ratio per 1,000 strength was 0.02. There were no cases reported among colored enlisted men serving in Europe.

The records show 15 cases in the American Expeditionary Forces from March to August, 1918. Of these, all but 2 occurred in men who had just arrived on transports, or who had developed the disease during the voyage.[1] Of the other two, one developed malignant pustule at the site of an incision caused by shaving. In several lots of shaving brushes collected from among arriving troops, the *Bacillus anthracis* was found by bacteriologists in England and in France.

TABLE 31.—*Anthrax. Admissions and deaths, by countries, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919*

	Admissions		Deaths, absolute numbers
	Absolute numbers	Ratios per 1,000	
Total officers and enlisted men, including native troops	149	0.04	22
Total officers and enlisted men, American troops	148	.04	22
Total officers	2	.01	
American troops, total enlisted men	146	.04	22
White	123	.03	19
Colored	6	.02	21
Color not stated	17		
Total native troops	1	.03	
U. S. Army in United States, including Alaska, enlisted men	100	.05	15
White	94	.05	14
Colored	6	.04	1
U. S. Army in Europe, excluding Russia, enlisted men	43	.03	6
White	26	.02	4
Color not stated	17		2

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

The distribution of primary admissions for anthrax by camps in the United States is given in Table 32. The disease was uncommon among the troops and occurred sporadically over practically the entire United States. The largest number of primary admissions for any one camp was for Camp Taylor, Ky., where nine cases were reported. Camp Mills, Long Island, N. Y., ranked second, with eight cases.

TABLE 32.—*Anthrax. Admissions and deaths, by specified camps of occurrence, enlisted men, United States Army, April 1, 1917, to December 31, 1919*

Camps of occurrence	Admissions		Deaths white [a]	Camps of occurrence	Admissions		Deaths white [a]
	White	Colored			White	Colored	
Bowie, Tex.	4			Logan, Tex.	1		0
Devens, Mass.	1		0	MacArthur, Tex.	1		0
Dix, N. J.	1		0	Mills, Long Island, N. Y.	7	1	
Dodge, Iowa	4	1	2	Pike, Ark.	1		0
Doniphan, Okla.	4		0	Shelby, Miss.	2		0
Fremont, Calif.	1		1	Sherman, Ohio	1		0
Gordon, Ga.	1		0	Taylor, Ky.	8	1	1
Grant, Ill.	0	1		Travis, Tex.	1		0
Greene, N. C.	1		0	Upton, Long Island, N. Y.	4		2
Hancock, Ga.	5		2	Wheeler, Ga.	1	1	0
Jackson, S. C.	3		2				
Lewis, Wash.	2		0	Total	54	5	10

[a] White troops only; one death was reported among colored troops at Camp Dodge.

ETIOLOGY

The exciting cause of anthrax was well understood before the World War, and its occurrence in man was well known. It was known that anthrax in man was an industrial disease and occurred commonly among persons working in tanneries on hides, or in factories where hair and wool had been obtained from animals dead of anthrax.

In England, in 1917, Coutts [2] reported the finding of anthrax bacilli and anthrax spores in shaving brushes made of imitation badger hair. He was able to trace the source of infection to the use of Chinese horsehair that had been imported as goat's-hair. With the outbreak of anthrax among the American soldiers and its most common site located on the face, the shaving brush was suspected as being the source of infection. Accordingly an investigation of the shaving-brush industry, with special reference to anthrax, was made by the United States Public Health Service.[3] It was shown that prior to the entry of the United States into the war all, or nearly all of the horsehair and pig bristles used in the United States came from Russia, China, or Japan, after having been submitted to cleaning and disinfecting processes in France or Germany. When the war began in 1914, the materials came direct to the United States by way of the Pacific coast. Through ignorance of the danger, or through an unwarranted confidence in certificates of disinfection that accompanied the importations, some American brush manufacturers took no pains to insure the safety of the material going into their products.[3]

Horsehair, which is the most frequent source of shaving-brush anthrax infection, is of both foreign and domestic source. The largest part of that used in the manufacture of shaving brushes in the United States comes from oriental sources, with China and Siberia furnishing by far the greater portion. With the investigation of establishments in the United States which manufacture

shaving brushes, a great variance was found in their method of disinfection. Some were deemed safe, while others were deemed totally unsafe. The methods of disinfection employed were, briefly, boiling for periods varying from one-half hour to 9 or 10 hours; steaming in streaming steam for from 1 to 8 hours; treatment in the autoclave for from 15 minutes to 3 hours, subjection to dry heat for varying periods up to a total of 24 hours. It was found that the disinfection process used on light-colored hair was less thorough than that used on the dark hair. Shaving brushes were secured in the open market and subjected to bacteriological examination. Some were found to be anthrax-infected.[3]

Coutts [2] reported that the horsehair from China and Siberia seemed to be particularly involved, especially gray or yellow hair imitating badger hair. The anthrax organisms were found not only on the free portions of the bristles, but also on the ends set in the handles. Anthrax was recovered from a new shaving brush at Camp Jackson in November, 1918. The hair was supposed to be badger's hair.[3]

It is believed that anthrax infection of the skin can occur only when there is an abrasion. In shaving, these abrasions are not infrequently made, and with the use of infected shaving brushes the explanation of the common site of the malignant pustule on the face is readily seen. Among tannery workers, butchers etc., direct inoculation takes place through abrasions from the handling of infected materials. The mode of infection in intestinal anthrax is through the mouth, either in the form of infected, uncooked meat, or by means of the hands carrying infection to the mouth. Workers in infected wool, through inhalation, occasionally contract a pulmonary form of anthrax, which is known as "wool sorters' disease." It is very probable that anthrax is not conveyed directly from man to man.

PATHOLOGY

The malignant pustule shows a circumscribed area with a black depressed necrotic center (carbon, of the French). It is raised and surrounded by an inflamed, edematous, indurated area. Vesiculation occurs in the early stages and surrounds the eschar. The lymph glands located on the chain of lymphatics from the malignant pustule show enlargement and acute inflammation. The spleen is enlarged and shows the presence of anthrax bacilli. In the so-called "wool-sorters' disease" the lungs show a pneumonic process. Occasionally the meninges are involved, showing meningitis. The cerebrospinal fluid in such cases is slightly increased and hemorrhagic, contains the *Bacillus anthracis,* and shows some increase in the cell count.

The following autopsy report and microscopical examination of tissues is that of a fatal case of anthrax, Fort Sam Houston, Tex.:

FORT SAM HOUSTON, TEX., *May 1, 1918.*

Autopsy Report No. 61, Pvt. A ——— C ——— C ———.

The body is that of a somewhat slenderly built man, about 167 cm. long. There is slight rigor mortis. There is only moderate livor mortis. The pupils are dilated and equal. The right half of the neck is swollen and slightly indurated. There is a small wound measuring 1 by ½ cm. at the upper angles of superior carotid triangle of the right side of the neck. The margins of the wound are rather sharply elevated above the skin. The center of the wound is depressed and is covered by a very adherent, brownish-black slough. There is an area of great induration about the base. The edema extends up to the lobe of the right ear and somewhat posterior to the ear and downward to the clavicle. The buccal mucous membrane is

quite pale. The chest is well formed. The abdomen is not distended. External genitals are negative. There is a slight general glandular enlargement and the glands of the right axilla are about the size of almonds.

The subcutaneous tissues on the upper anterior portion of the chest are edematous. The peritoneal cavity is almost dry. The liver reaches 5 cm. below the ensiform. Diaphragm reaches to the fifth rib on right and fifth interspace on the left. Both pleural cavities are free from fluid. There is slight edema of the mediastinal tissues. * * *

The tissues of the neck are extremely edematous, and just below the lesions described above there is a fibrinous exudate in the underlying fascia and muscle. On section the central portion was found to be made up of a dark-brown eschar. There was no pus in the cervical tissues.

Brain: Lumbar puncture was done at the beginning of the autopsy and only a small amount of very bloody fluid could be obtained. Upon removal of skull cap and incision of the dura a considerable quantity of fluid similar to that obtained on puncture escaped. The brain was found to be entirely covered by a very hemorrhagic exudate, which on the convexity was about 3 mm. thick. The concavity of the brain was covered with a much thinner exudate, which extended down upon the cord as far as visible through the foramen magnum. This exudate is strikingly hemorrhagic. The ventricles do not contain any visible exudate. The dura itself on the inner surface is quite smooth. Smears made from the exudate on the brain and from the spinal fluid showed a large bacilli in long chains in great numbers. The same organism was obtained in pure culture from the heart blood.

Anatomical diagnosis.—Anthrax pustule of neck; hemorrhagic meningitis (*B. anthracis*) calcified tubercles left lung.

Cause of death.—Anthrax pustule of neck; hemorrhagic meningitis (*B. anthracis.*)

Microscopical Examination of Tissues

(Autopsy No. 61)

May 3, 1918.

Pustule from neck.—There is shown skin, subcutaneous tissue, fat, muscle. The epithelium is intact over a portion of the surface. At the site of the infection there is an area of necrosis and the epithelium over this area has disappeared. At the margin of the necrotic area are a few small vesicles. The necrosis extends down into the dermis. Throughout the section there is very extreme infiltration, with polymorphonuclear leucocytes, and there are large areas of hemorrhage. In the fascia overlying the muscle the edema is marked and some fibrin has accumulated.

Lymph gland.—From the right side of the neck. There is some edema, but the striking feature is the occurrence of large, mononuclear cells. These cells are found in especially large masses in the germinal centers. The cells have large, pale, vesicular nuclei, and the cytoplasm stains pale blue. Two nuclei are occasionally found in a single cell, and more rarely three nuclei are seen. The cytoplasm of some has clear droplets in it and many of the cells contain engulfed lymphocytes. These large cells are also present to a less extent throughout the gland, and the lymph sinuses are stuffed with them. The blood vessels are dilated and the lining endothelial cells are swollen. Many small hemorrhages are seen.

* * * * * * *

Brain.—The pia is edematous and there is an accumulation of polymorphonuclear leucocytes within it. The exudate is strikingly hemorrhagic; indeed, this is the most prominent feature. There are many phagocytic cells loaded with blood pigment. Shadowy outlines of bacilli can be seen in the exudate. There is a narrow zone of edema at the margin of the cortex.

Weigert stains were made of sections of the pustule, lung, lymph gland, spleen, liver, and brain. Typical bacilli were found in the pustule, lymph gland, the capillaries of the lung, and in the sinusoids of the liver. They were however, not numerous. The bacilli were more abundant in the spleen. The exudate on the brain contained myriads of typical anthrax bacilli. The bacilli did not penetrate into the brain substance, but small capillaries in the cortex were frequently plugged with the organisms, and there was about the vessel a dense halo of bacilli.

Diagnosis.—Anthrax pustule of neck; hemorrhagic meningitis (*B. anthracis*); encapsulated tubercles, left lung.

REPORT OF PATHOLOGICAL EXAMINATION

ARMY MEDICAL MUSEUM, *July 30, 1918.*

Case of private A. C. B., from Fort Sam Houston, Tex.

Clinical diagnosis: hemorrhagic meningitis; *B. anthrax;* anthrax pustule on neck.

Specimen is the right hemisphere of a brain with the stem and stub of cord in excellent state of preservation.

The entire outer surface of the cerebrum is characterized by a thick shriveled mat of subpial hemorrhage, which is most prominent over the parietal and frontal lobes.

There is abundant exudation about the blood vessels, and masses and streaks of yellowish white material is distributed over all surfaces of the cerebrum. This exudate extends deeply into the sulci where it fuses with large amounts of hemorrhagic débris.

The blood vessels on all surfaces are notably congested and the basal surface evidences rusting.

The mesial cerebral surface is covered by a profusely hemorrhagic pia mater, which strips easily, leaving the gyri covered by, and the sulci filled with pus, coagulated blood and granular débris. All vessels are hyperemic and the sheaths filled wlth pus extensions.

The pia of the cerebellum is filled with pus and there is diffuse subpial hemorrhage and deposits of blood pigments.

Cut surfaces of the cerebellum show extensions of the hemorrhagic exudate into the extreme depths and ramifications of the fissures.

MICROSCOPICAL EXAMINATION

I. *Cerebral cortex.*—(1) The pia mater covering these portions is deeply infiltrated with a hemorrhagic exudate rich in chained bacilli. Red blood corpuscles, leucocytes, and anthrax bacilli are diffusely spread throughout the structure.

(2) The pial vessels are dilated and packed with red blood cells, but the lumina are relatively free from the organisms. Very little fibrin is noted about the vessels.

(3) The deeper cortical vessels contain bacilli and numerous red blood cells, and there is a large amount of perivascular hemorrhage filled with masses of organisms.

(4) Numerous small capillaries are occluded by pus cells.

(5) The white substance is markedly edematous, but no bacilli are noted.

(6) The ganglion cells are pale and granular with fragmentedc hromatin material. Many cells are vacuolated and shrunken, presenting eccentric muclei.

II. *Cerebellar cortex.*—(1) The sections are characterized by a thickened, hemorrhagic, purulent pia containing masses of chained bacilli and dilated vessels. This process extends deeply into the cerebellar fissures, and in places into the molecular layer.

(2) A few perivascular hemorrhages are present in the cortex, but only an occasional bacillus is noted.

(3) A few bacilli are seen about and embedded in the walls of the small vessels of the granular layer, and among the Purkinje's cells.

(4) The Purkinje's cells show acute degenerative processes, with cloudiness, and some shrinkage.

Summary.—Acute hemorrhagic, purulent meningo-encephalitis (*B. anthracis*).

SYMPTOMS

There are three recognized types of anthrax. In the first and most common variety, the lesion is located on the skin and is known as malignant pustule. The second form is intestinal; the third, pulmonary. An analysis of anthrax occurring in the Army during the war shows no cases of pulmonary anthrax. Cases reported as primary admissions commenced with the malignant pustule and, in but one exception, on the shaving area of the face or neck. Several cases of intestinal anthrax and anthrax meningitis followed; the records show anthrax septicemia in the majority of cases.

Commonly, the disease commences as a red papule located at the site of an abrasion. In a few hours this papule enlarges and becomes a vesicle containing a turbid, hemorrhagic fluid. Itching occasionally occurs, but commonly is absent. The lesion enlarges, becomes depressed in the center, and is characteristically black. The surrounding tissue is hard from blocking of the lymphatics, and, bordering the eschar, is usually a ring of vesicles. Febrile symptoms occur early. The lymph glands draining the involved area become involved and, where the malignant pustule is located on the face and neck, much swelling and distortion of the parts occur. The pustule, which is usually singular, increases rapidly in size. The *Bacillus anthracis* can be found in the malignant pustule on examining the contents under the eschar.

Where the infection extends into the lymph and blood streams, there is an increased polymorphonuclear leucocytosis. Commonly a marked leucocytosis is not present. The spleen is usually enlarged. The cerebrospinal nervous system is not usually involved. Headache, stiffness of the neck, and disturbed reflexes indicate involvement of the meninges.

The onset of the intestinal form of anthrax is usually accompanied by vomiting, severe abdominal pains, and diarrhea. Cyanosis and circulatory collapse occurred in the case reported by Norton and Kohman.[4] The feces often show the anthrax bacillus. In these cases there is an increase of fluid in the abdomen. This fluid is cloudy and contains blood. The lesions are commonly located in the small intestine, with involvement of Peyer's patches. Norton and Kohman believed that the intestinal carbuncle may be formed by a blood stream infection as well as by the alimentary route. In the former cases, the anthrax bacillus may not be found in the feces. The mortality is exceedingly high, possibly 100 per cent.

COMPLICATIONS AND CONCURRENT DISEASES

Anthrax, being an acute disease, naturally would not result in soldiers being discharged from the service directly on that account. The records show four cases discharged on account of disability following anthrax. The disability following the malignant pustule was usually the deformity following excision, where this form of treatment was applied. Of the 149 primary admissions, 25 were reported as having some concurrent disease. Among these there were 12 deaths, a case of mortality of 48 per cent.

DIAGNOSIS

Diagnosis of malignant pustule is ordinarily not attended with difficulty if one is familiar with the appearance of this lesion. The carbonlike eschar of from 1 to 3 centimeters in diameter, reposing in a crater bordered by numerous vesicles and surrounded by a red areola and considerable edema, is characteristic. The absence of suppuration and pain, with systemic symptoms such as malaise, fever, headache, and prostration should lead to an examination of the lesion for anthrax bacilli, the finding of which is conclusive proof of the correctness of the diagnosis. The occurrence of a lesion of the above description on the parts of the body habitually uncovered is suggestive. The intestinal form of anthrax is usually diagnosed at autopsy. The diagnosis of anthrax

meningitis is based on the presence of symptoms and signs of meningitis plus the finding of the anthrax bacillus in the spinal fluid. Pulmonary anthrax is diagnosed by the presence of physical signs of a pneumonia with anthrax bacilli present in the sputum. Anthrax septicemia is a late manifestation of any of the above-mentioned forms of anthrax and is diagnosed by the finding of the *Bacillus anthracis* in the blood.

PROGNOSIS

The prognosis in anthrax depends very largely on early diagnosis and treatment. Where diagnosis is made very early and strenuous treatment instituted, the mortality is low. The disease is particularly fatal in the meningitic and intestinal forms. The mortality at the Boston City Hospital for several years ending in 1918 was 31 per cent.[5] The average case mortality in the United States is 13 to 24 per cent and for the Army during the World War it was 14.7 per cent.

PROPHYLACTIC MEASURES

Anthrax is an occupational disease and prophylaxis, from the standpoint of occurrence in man, rests with the Government in promulgating and enforcing regulations governing the importation of industrial products, especially hair, hides, wool, etc., from countries where anthrax is common. Interstate regulations also are required, as the disease occurs in animals in the United States, although the occurrence is to a much less degree than in Russia, Siberia, and China. Some of these regulations are contained in a report issued by the United States Bureau of Labor.[6]

The carcasses of animals dying from anthrax should be covered with quicklime and buried deeply in the earth. Burning in the open is not recommended, as bursting from heat follows, with scattering of the infection. The carcasses should never be permitted to remain on the surface to be destroyed by animals, for it has been shown that the vulture, at least, can spread anthrax after feeding on such carcasses.

The spores of anthrax are particularly resistant to chemical heat and drying. It has been shown that these spores have remained viable 17 years in fields infected by the disease. Spores do not occur in man, but are probably the most important factor to be considered in controlling the disease in lower animals. Both active and passive immunization of animals against anthrax are used in the control of epidemics. Pasteur first practiced the use of attentuated cultures of anthrax bacilli as a prophylaxis.[7] Rand[8] reported a vaccine that remained potent over a considerable period of time, and that, when used, rendered the animal immune almost immediately.

Although it has been supposed that the eating of infected meats has caused intestinal anthrax, it was the shaving brush that was the agent of special interest to the Army during the World War. There is nothing on record to show that food has ever been the cause of anthrax in the Army. With the occurrence of malignant pustule on the face of soldiers, instructions were issued by the Surgeon General to sterilize all shaving brushes before issue or sale from Government sources.[9] Several methods were tried which proved entirely unsatis-

factory, as the brush was destroyed during the process. The following method seems to have been the best, although none was entirely satisfactory.[9] Immersion for four hours in a 10 per cent solution of formalin heated all the time to 110° F. After this, the brush is dried and ready for issue or sale.

It has been shown that the ends of the hair or bristles set in the handles of shaving brushes are occasionally infected; therefore, sterilization by immersion in chemicals probably had no effect upon anthrax organisms and, in view of the fact that "two hours of boiling are required to kill all spores contained in a liquid culture,"[6] it is doubtful if the attempts at sterilization had any effect upon the occurrence of anthrax in soldiers. Since the processes used were not only destructive to the brush, but detracted from its appearance, it was difficult to have the regulations carried out. No attempt was made to force retail civilian dealers to sterilize their brushes before sale, and it is very probable that this prophylactic measure was of little or no value in controlling anthrax, or in reducing the number of cases in the Army.

The leather chin strap was supposed to have been the source of infection in several soldiers,[10] as the malignant pustule appeared where the strap rubbed the skin. Toilet soap of two soldiers suffering from anthrax was shown to contain anthrax organisms and was thought to have been the source of infection.[11] As the number of cases was small, the institution of prophylaxis along these lines was not undertaken.

Soldiers suffering from anthrax were transferred to hospital and confined to contagious wards for treatment and as control measures. A search of the records fails to reveal any case of anthrax transferred from man to man.

TREATMENT

Treatment of anthrax is both local and general. Success depends upon early diagnosis and rigorous treatment. Brown and Simpson [12] have shown that the routine cauterization with phenol of all wounds in persons exposed to anthrax prevents occurrence of this disease.

The local treatment used during the war was excision, incision, cauterizing by actual cautery and chemicals, local application of drugs, and subcutaneous injection of immune serum into or around the malignant pustule. The general treatment consisted in the subcutaneous, intramuscular, or intravenous injection of serum.

No one treatment was universally used. Ludy and Rice [13] infiltrated the tissues about the lesion with antianthrax serum of from 30 c. c. to 50 c. c. at a dose. The lesion then was dissected out by the thermo-cautery, an effort being made to remain at least one-half inch beyond the border of the malignant pustule. In addition, immune serum in 75 c. c. doses was given intravenously, after dilution with 50 c. c. salt solution, and intramuscular administration in 75 c. c. doses of antianthrax serum was used. The wound was dressed at 24-hour intervals, employing a mixture of camphor, 7 parts; phenol, 3; glycerin, 40; and alcohol, 180. The serum therapy was repeated every eight hours. Gaskill [11] did not advocate excision. He used sunlight on two cases, with recovery. Mix,[14] at the base hospital, Camp Mills, Long Island, injected antianthrax serum intravenously in from 100 c. c. to 200 c. c. doses. He recommended

excision of the pustule and emphasized the importance of early diagnosis. He reported 6 cases, with 1 death. Local treatment consisted of boric acid dressings every two hours and an ice bag applied to the head. Mix compared the effects of serum in anthrax with that of diphtheria antitoxin in diphtheria, as shown by the immediately produced improvement in the local and general condition of the patient. He believed that incision is not always necessary and that possibly anthrax may be treated with serum in the same satisfactory manner as diphtheria. Amory and Rappaport [10] reported 4 cases at the embarkation hospital, Newport News, Va., with recovery. The pustule was excised under local anesthesia without any attempt to control hemorrhage, as the loss of blood from the site of infection was advisable. Cauterization, and injection of 5 per cent phenol into the cellular tissues around the lesion, followed by the application of continous alcohol dressings, were considered indispensable. Later, skin grafting was used for cosmetic purposes and for shortening the period of convalescence. Antianthrax serum was used in two cases. In one the effect was beneficial; in the other, it was commenced but was discontinued on account of a rather severe reaction.

The action of antianthrax serum is not definitely understood. It is not bactericidal and its agglutinating and precipitating qualities are questioned.

In the intestinal, pneumonic, and meningeal varieties of anthrax, serum and symptomatic treatment constituted the methods used during the war. There is no special treatment in the intestinal form as in anthrax pneumonia. Anthrax meningitis is temporarily improved symptomatically by lumbar puncture.

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CHAPTER VI

DIPHTHERIA [a]

STATISTICAL CONSIDERATIONS

The influence of diphtheria on the admission rate of the Army was not sufficient to place it among the 30 most important diseases, but it stood eighteenth among causes of death and twenty-eighth for time lost.

The interesting features of its occurrence are: It was decidedly more prevalent among white enlisted men than among colored; the case fatality rate was higher among the colored; there were only three instances of the prevalence assuming epidemic characteristics.

As shown in Table 33, the total annual strength of the Army for the period 1917–1919 was 4,128,479; the annual admission rate per 1,000 for the period was 2.64; the death rate, 0.04 per 1,000; and the noneffective rate, 0.21 per 1,000. Among native troops (Philippine Islands, Hawaii, and Porto Rico) the disease incidence was insignificant, 2 cases occurring in a strength of 36,000 and no deaths. The annual admission rate among officers for the entire period was 1.56 per 1,000, as compared to 2.72 for enlisted men; the annual death rates, respectively, were: Officers 0.03 per 1,000 and enlisted men 0.04; the noneffective rates 0.10 per 1,000 and 0.22 per 1,000.

TABLE 33.—*Diphtheria. Admissions, deaths, discharges for disability, and days lost, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and annual ratios per 1,000 strength*

	Total mean annual strengths	Admissions		Deaths		Discharges for disability		Days lost	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Noneffective ratios per 1,000 strength
Total officers and enlisted men, including native troops	4,128,479	10,909	2.64	177	0.04	80	0.02	317,050	0.21
Total officers and enlisted men, American troops	4,092,457	10,907	2.67	177	.04	80	.02	317,023	.21
Total officers	206,382	322	1.56	7	.03	1	.00	7,835	.10
Total American troops:									
White	3,599,527	9,650	2.68	154	.04	77	.02	285,080	.22
Colored	286,548	205	.72	5	.02	2	.01	4,863	.05
Color not stated		730		11				19,245	
Total	3,886,075	10,585	2.72	170	.04	79	.02	309,188	.22
Total native troops (enlisted)	36,022	2	.06					27	.00
Total Army in the United States, including Alaska:									
Officers	124,266	180	1.45	4	.03			4,182	.09
White enlisted	1,965,297	5,577	2.84	89	.05	51	.03	137,369	.19
Colored enlisted	145,826	127	.87	3	.02	2	.01	2,901	.05
Total enlisted	2,111,123	5,704	2.70	92	.04	53	.03	140,270	.18
Total officers and men	2,235,389	5,884	2.63	96	.04	53	.02	144,452	.18

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

TABLE 33.—*Diphtheria. Admissions, deaths, discharges for disability, and days lost, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and annual ratios per 1,000 strength*—Continued

	Total mean annual strengths	Admissions		Deaths		Discharges for disability		Days lost	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Non-effective ratios per 1,000 strength
U. S. Army in Europe, excluding Russia:									
Officers	73,728	137	1.86	3	.04	1	.01	3,563	.13
White enlisted	1,469,656	3,921	2.67	61	.04	22	.01	143,552	.27
Colored enlisted	122,412	74	.60	1	.01			1,923	.04
Color not stated		728		11				19,062	
Total enlisted	1,592,068	4,723	2.97	73	.05	22	.01	164,537	.28
Total officers and men	1,665,796	4,860	2.92	76	.05	23	.01	168,100	.28
Officers, other countries	8,388	5	.60					90	.03
U. S. Army in Philippine Islands:									
White enlisted	16,995	3	.18					82	.01
Total enlisted	21,451	3	.14					82	.01
U. S. Army in Hawaii, white enlisted	16,161							47	.01
U. S. Army in Panama, white enlisted	19,688	19	.97					206	.03
U. S. Army in other countries not stated:									
White enlisted		26		1				919	
Colored enlisted		1		1				6	
Color not stated		2						183	
Total *	14,232	29	2.04	2	.14			1,108	.21
Transports:									
White enlisted	97,498	104	1.07	3	.03	4	.04	2,905	.08
Colored enlisted	10,535	3	.28					33	.01
Total	108,033	107	.99	3	.03	4	.04	2,938	.07
Native troops enlisted:									
Philippine Scouts	18,576	1	.05					15	.00
Hawaiians	5,615	1	.18					12	.01

* Separate strength of white and colored not available.

Table 34 shows the number of admissions and deaths, together with the annual rates, by months, of white and colored enlisted men, United States Army, for both the United States and Europe.

TABLE 34.—*Diphtheria. Admissions and deaths, by months, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919. Absolute numbers and annual ratios per 1,000 strength*

Month and year	White enlisted men									
	United States					Europe				
	Mean strength	Admissions		Deaths		Mean strength	Admissions		Deaths	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
1917										
April	183,758	15	0.98							
May	245,454	37	1.81	2	0.10	626				
June	309,205	67	2.60	2	.08	12,794	1	0.89		
July	458,817	108	2.82	2	.05	28,821	13	5.41		
August	562,714	152	3.24	1	.02	50,882	7	1.65		
September	776,466	213	3.29			70,266	10	1.71		
October	1,032,244	300	3.49	1	.01	92,139	8	1.04		
November	1,061,422	401	4.53	2	.02	123,429	15	1.46		
December	1,129,065	349	3.71	8	.09	160,178	18	1.35		
Total	479,929	1,642	3.42	18	.04	44,928	72	1.60		
1918										
January	1,096,434	424	4.64	16	.18	193,264	43	2.67		
February	1,095,039	434	4.76	14	.15	223,130	62	3.33	4	0.22
March	1,129,223	531	5.64	9	.10	283,268	323	13.68	10	.42
April	1,168,558	607	6.23	6	.06	388,048	209	6.46	1	.03
May	1,197,757	356	3.57	4	.04	587,240	338	6.91	4	.08
June	1,303,746	160	1.47			796,427	321	4.84	5	.08
July	1,328,513	111	1.00			1,063,192	237	2.67	4	.05
August	1,284,247	101	.94			1,266,592	182	1.72	1	.01
September	1,321,440	111	1.01	2	.02	1,527,793	180	1.41	3	.02
October	1,343,933	79	.71	1	.01	1,635,321	248	1.82	4	.03
November	1,255,195	122	1.17	1	.01	1,682,836	282	2.01	3	.02
December	941,219	122	1.56	2	.03	1,591,962	288	2.17	5	.04
Total	1,205,442	3,158	2.62	55	.05	936,589	2,713	2.90	44	.05
1919										
January	672,937	172	3.07	7	.12	1,488,683	270	2.18	2	.02
February	471,815	147	3.74	5	.13	1,310,083	248	2.27	5	.05
March	406,839	166	4.90			1,115,693	187	2.01	2	.02
April	339,836	130	4.59	2	.07	853,425	142	2.00	3	.04
May	291,810	73	3.00	2	.08	569,842	101	2.13	1	.02
June	246,903	27	1.31			271,633	77	3.40	1	.04
July	215,104	16	.89			111,634	29	3.12		
August	156,791	9	.69			48,006	16	4.00		
September	149,360	9	.72			30,315	4	1.58		
October	139,877	10	.86			21,055	15	8.55		
November	132,403	8	.73			18,920	14	8.88		
December	135,441	10	.89			18,379	22	14.36		
Total	279,926	777	2.78	16	.06	488,139	1,125	2.30	14	.03
Month not stated							11		3	
Total for period	1,965,297	5,577	2.84	89	.05	1,469,656	3,921	2.67	61	.04

TABLE 34.—*Diphtheria. Admissions and deaths, by months, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919. Absolute numbers and annual ratios per 1,000 strength*—Continued

Month and year	Colored enlisted men									
	United States					Europe				
		Admissions		Deaths			Admissions		Deaths	
	Mean strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Mean strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
1917										
April	4,870									
May	5,826									
June	5,171									
July	6,675									
August	8,519									
September	9,409	2	2.55							
October	21,795	2	1.10			935				
November	39,225	6	1.84			2,392				
December	36,851	8	2.61			5,346	3	6.73		
Total	11,529	18	1.56			723	3	4.15		
1918										
January	50,705	3	.71	1	0.24	8,673				
February	49,955	8	1.92			9,664				
March	54,814	6	1.31			11,541	2	2.08		
April	59,015	13	2.64			12,667	2	1.89		
May	87,650	14	1.92			28,279	3	1.27		
June	89,305	4	.54			33,208	1	.36		
July	124,976	4	.38	1	.10	47,171	2	.51		
August	168,422	8	.57			78,734	1	.15		
September	164,846	2	.15			91,270	3	.39		
October	182,705	5	.33	1	.07	138,827	6	.52		
November	150,587	8	.64			148,679	8	.65	1	0.08
December	104,140	6	.69			148,372	16	1.29		
Total	107,260	81	.76	3	.03	63,090	44	.70	1	.02
1919										
January	68,337	7	1.23			140,396	13	1.11		
February	66,104	10	1.82			131,219	7	.64		
March	44,634	5	1.34			123,152	2	.19		
April	29,824	2	.81			119,801	3	.30		
May	20,780					108,650				
June	18,562					64,166	1	.19		
July	20,058	2	1.20			12,508	1	.96		
August	18,013					1,741				
September	11,322					1,287				
October	9,084	1	1.32			185				
November	8,792	1	1.36			83				
December	8,935									
Total	27,037	28	1.04			58,599	27	.46		
Month not stated										
Total for period	145,826	127	.87	3	.02	122,412	74	.60	1	.01

The following summary from Table 34 shows the annual admission rates by location, years, and race:

For white troops in United States:

1917	3.42
1918	2.62
1919	2.78

For white troops in American Expeditionary Forces:

1917	1.60
1918	2.90
1919	2.30

For colored troops in United States:

1917	1.56
1918	.76
1919	1.04

For colored troops in American Expeditionary Forces:

1917	4.15
1918	.70
1919	.46

A study of these figures shows that white troops had a much higher rate in the United States during 1917 and 1919 than did those in the American Expeditionary Forces; while the latter, during 1918, the period of greatest activity overseas, had the higher rate. Seasonal variation was not significant, except that in 1917 the prevalence at home remained consistently high throughout the year; while in 1918 and 1919 it was high during late winter and spring, and low during the summer. In the American Expeditionary Forces the incidence rate was excessively high in July, 1917; it then dropped to a low point and remained low until late winter, when it climbed rapidly, reaching the peak in March and remaining fairly high until midsummer. During 1919 in the American Expeditionary Forces the rise came in June and, except during September, remained high to the end of the year, reaching the high point of the war (14.36 per 1,000) in December.

There seems very little correlation throughout the period between the rate of prevalence at home and abroad. One might expect to find a lag in the American Expeditionary Forces curve, showing a summer rise, produced by an influx of carriers from the spring peak in the United States; there is some indication of such a condition in the early part of 1918.

Considering the whole period, white troops in the United States had an annual admission rate of 2.84 per 1,000, while those in Europe had 2.67. Among the colored troops the rate at home was 0.87 and in Europe 0.60. There is nothing significant in the difference shown between troops at home and abroad, and comparison is hardly justified. All troops numbered as in the American Expeditionary Forces were also counted at some period among home troops, and it is reasonable to presume that unknown passive carriers were sources both at home and in Europe.

Table 33 indicates that for the whole period, April 1, 1917, to December 31, 1919, the admission rate for the Army in the American Expeditionary Forces was 2.92 per 1,000; while that of the Army at home was 2.63. This difference of 29 cases per 100,000 men is not significant, and was undoubtedly influenced, particularly in the early part of the period, by imported cases. For example, in December, 1917, the strength of colored troops was 5,346 (Table 34), or 3 per cent of the entire strength, yet they furnished 3 cases, or 15 per cent of the total (21) for that month. It is quite probable that the cases in question originated in the United States.

OCCURRENCE IN THE UNITED STATES

Figures for the Army in the United States (Table 33) show a total of 5,884[b] cases in an aggregate strength of 2,235,389, or an annual incidence rate of 2.63 per 1,000. The deaths totaled 96, making an annual rate of 0.04 per 1,000 and a case fatality rate of 1.6 per cent, or 16 deaths per 1,000 cases.

As noted previously and shown graphically in Chart XXX, there was a noticeable difference between white and colored troops in resistance to diphtheria. As conditions of exposure were practically the same for both, the variation in prevalence is best accounted for by the hypothesis of crediting the colored soldiers with higher resistance or less susceptibility. However, when the appar-

[b] This figure represents primary admissions.

ent higher immunity in the latter race is broken down by invasion, there is less resistance to the toxic effect of the microorganism, and the case fatality is much higher than among the whites; 23 per 1,000 as against 16 per 1,000.

The days lost for each case (Chart XXX) are practically the same for white and colored, and the noneffective rate correlating with the admission rate, is, of course, much higher for the white troops.

Officers in the United States (Table 33) show an aggregate strength of 124,266 and 180 cases, or an annual rate of 1.45 per 1,000; among these there were 4 deaths, giving a case fatality of 2.22 per cent, or 22 deaths per 1,000 cases, which is considerably higher than that for the enlisted men (16 per 1,000). It is interesting to note (Table 33) that the officer strength, 124,266 is approximately within 20,000 of the colored strength, and the case fatality rates are fairly close, the difference being 1 death per 1,000 cases.

The lower incidence rate among officers is probably due to their more advanced age, as we know that immunity to diphtheria increases with each year beyond childhood. The higher fatality rate among cases may be assigned to the same hypothesis applied to colored troops. It is well known in all children's diseases attacking adults that the case fatality is high. Presumably, the adult victims are a small percentage who have built up little or no immunity, and the virus finds a favorable soil for development.

BY CAMPS

A study of Chart XXXI and Table 35 shows at once that camps in the central area had a decided influence on the general admission rate. Camp Doniphan, Okla.; Camp Pike, Ark.; Camp Funston, Kans.; Camp Grant, Ill.; and Camp Dodge, Iowa, furnished 17 per cent of the aggregate strength and 50 per cent of the diphtheria.

These camps were populated from the agricultural area of the United States, and possibly a large proportion of the men had never been subjected to the exposure incident to density of population and industrial conditions of the East, and hence had acquired less immunity. Chart XXXII shows graphically the decided susceptibility of men from the agricultural States. It is quite true that many of our southern camps drew men from agricultural regions also, but a large percentage of their strength was colored, which, as already shown, had a decidedly racial resistance. The northwest area had a rate just below the average for the United States, but this position was characteristic of the men from this section, for all causes of admission.

DIPHTHERIA. COMPARATIVE RATES

WHITE & COLORED ENL. MEN-UNITED STATES

APRIL, 1917 — DEC., 1919

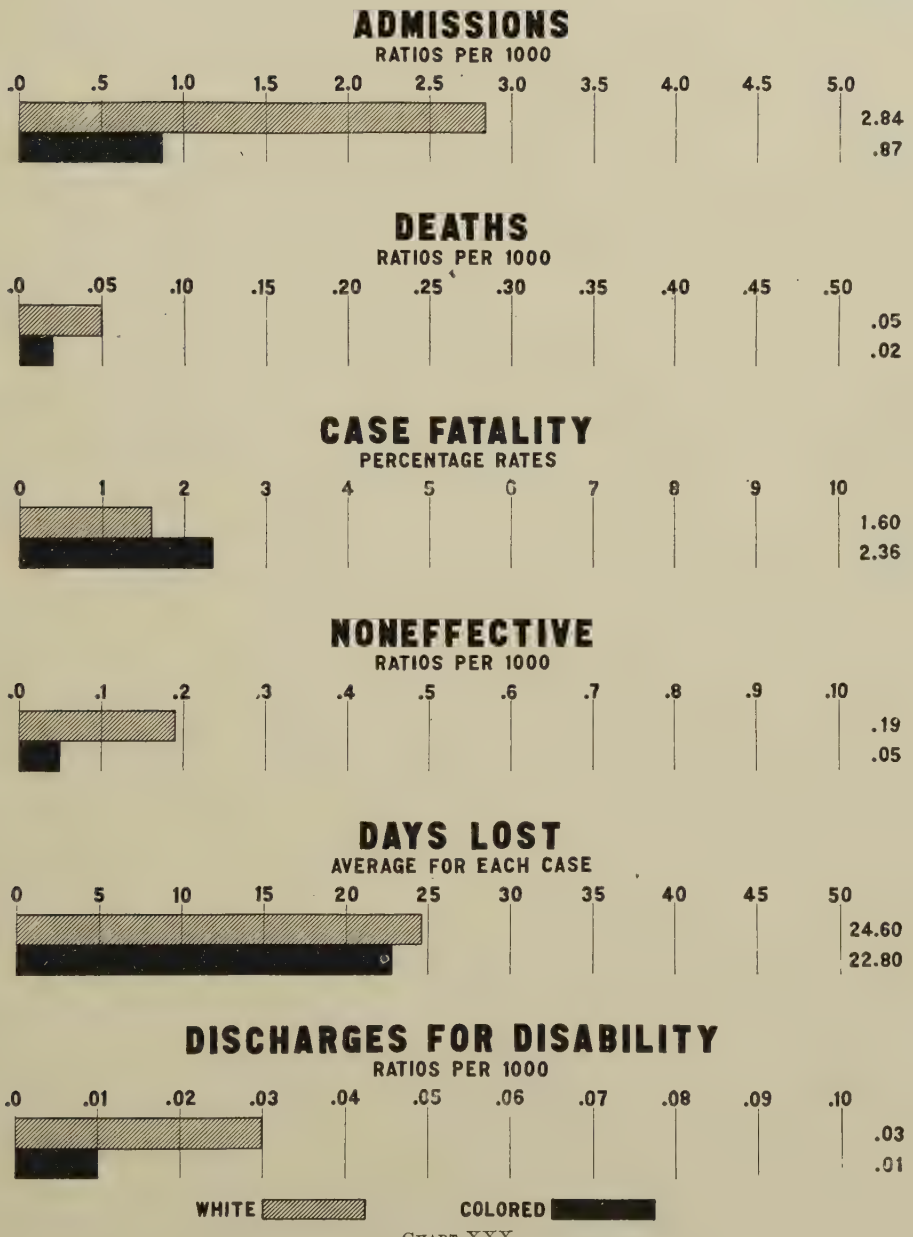

CHART XXX

TABLE 35.—*Diphtheria. Admissions and deaths, by camps of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919, inclusive. Absolute numbers and annual ratios per 1,000 strength*

Camps	Total mean strength	White enlisted men				Colored enlisted men				Total enlisted men				Case fatality rates (per cent)
		Admissions		Deaths		Admissions		Deaths		Admissions		Deaths		
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	
Beauregard, La	20,625	6	0.30			1	2.37			7	0.34			
Bowie, Tex	26,193	38	1.51			7	7.35			45	1.72			
Cody, N. Mex	22,636	81	3.58	2	0.09					81	3.58	2	0.09	2.47
Custer, Mich	37,631	69	1.90	2	.06					69	1.83	2	.05	2.90
Devens, Mass	47,921	42	.92	2	.04	1	.45			43	.90	2	.04	4.65
Dix, N. J	49,786	64	1.42			3	.62			67	1.35			
Dodge, Iowa	39,032	173	5.21	3	.09	7	1.21			180	4.61	3	.08	1.67
Doniphan, Okla	26,747	577	21.57	7	.26					577	21.57	7	.26	1.21
Eustis, Va	6,780													
Forrest, Ga	8,980													
Fremont, Calif	15,414	17	1.10	1	.06					17	1.10	1	.06	5.89
Funston, Kans	56,222	345	6.89	5	.10	16	2.59			361	6.42	5	.09	1.39
Gordon, Ga	44,871	20	.53			2	.29			22	.49			
Grant, Ill	49,256	216	5.10	4	.09	11	1.59			227	4.61	4	.08	1.76
Greene, N. C	29,710	126	4.81	1	.04			1	0.28	126	4.24	2	.07	1.59
Greenleaf, Ga	11,959	3	.25							3	.25			
Hancock, Ga	37,994	38	1.04							38	1.00			
Humphreys, Va	12,836	4	.41	1	.10					4	.31	1	.08	.00
Jackson, S. C	42,011	19	.52			3	.59			22	.52			
Johnston, Fla	22,267	18	.91							18	.81			
Kearny, Calif	25,472	47	1.85	1	.04					47	1.85	1	.04	2.13
Lee, Va	57,635	22	.43			5	.75			27	.47			
Lewis, Wash	47,792	98	2.07	1	.02					98	2.05	1	.02	1.02
Logan, Tex	27,734	86	3.23	1	.04	2	1.87			88	3.17	1	.04	1.14
MacArthur, Tex	25,271	106	4.36	1	.04					106	4.19	1	.04	.94
McClellan, Ala	28,664	16	.60			1	.47			17	.59			
Meade, Md	50,033	84	2.00	1	.02	4	.50			88	1.76	1	.02	1.14
Mills, N. Y	24,197	203	8.85	1	.04	3	2.39			206	8.51	1	.04	.49
Pike, Ark	49,587	226	5.53	8	.20	2	.23			228	4.59	8	.16	3.51
Sevier, S. C	27,786	8	.31							8	.29			
Shelby, Miss	30,432	17	.59							17	.56			
Sheridan, Ala	26,507	52	2.03			2	2.26			54	2.04			
Sherman, Ohio	42,750	114	3.08	2	.05	8	1.38	1	.17	122	2.85	3	.07	2.46
Syracuse, N. Y	3,367	1	.30							1	.30			
Taylor, Ky	46,962	47	1.10							47	1.00			
Travis, Tex	44,264	19	.51			3	.46			22	.50			
Upton, Long Island, N. Y	44,871	43	1.07			5	1.07			48	1.07			
Wadsworth, S. C	31,809	64	2.12			1	.60			65	2.04			
Wheeler, Ga	25,726	13	.54							13	.51			
Others	339					2	5.90			2	5.90			
Total	1,270,069	3,122	2.69	44	.04	89	.80	2	.02	3,211	2.53	46	.04	1.43

Among the camps in the Central United States which had high admission rates, the following case fatalities are found (calculated from cases and deaths, Table 35):

Camp Pike, Ark.:
- Cases 226
- Deaths 8
- Case fatality (per cent) 3.54

Camp Grant, Ill.:
- Cases 216
- Deaths 4
- Case fatality (per cent) 1.85

Camp Dodge, Iowa:
- Cases 173
- Deaths 3
- Case fatality (per cent) 1.73

Camp Funston, Kans.:
- Cases 345
- Deaths 5
- Case fatality (per cent) 1.45

Camp Doniphan, Okla.:
- Cases 577
- Deaths 7
- Case fatality (per cent) 1.21

DIPHTHERIA, BY CAMPS
ADMISSIONS, WHITE ENLISTED MEN, U. S.
APRIL, 1917–DEC., 1919

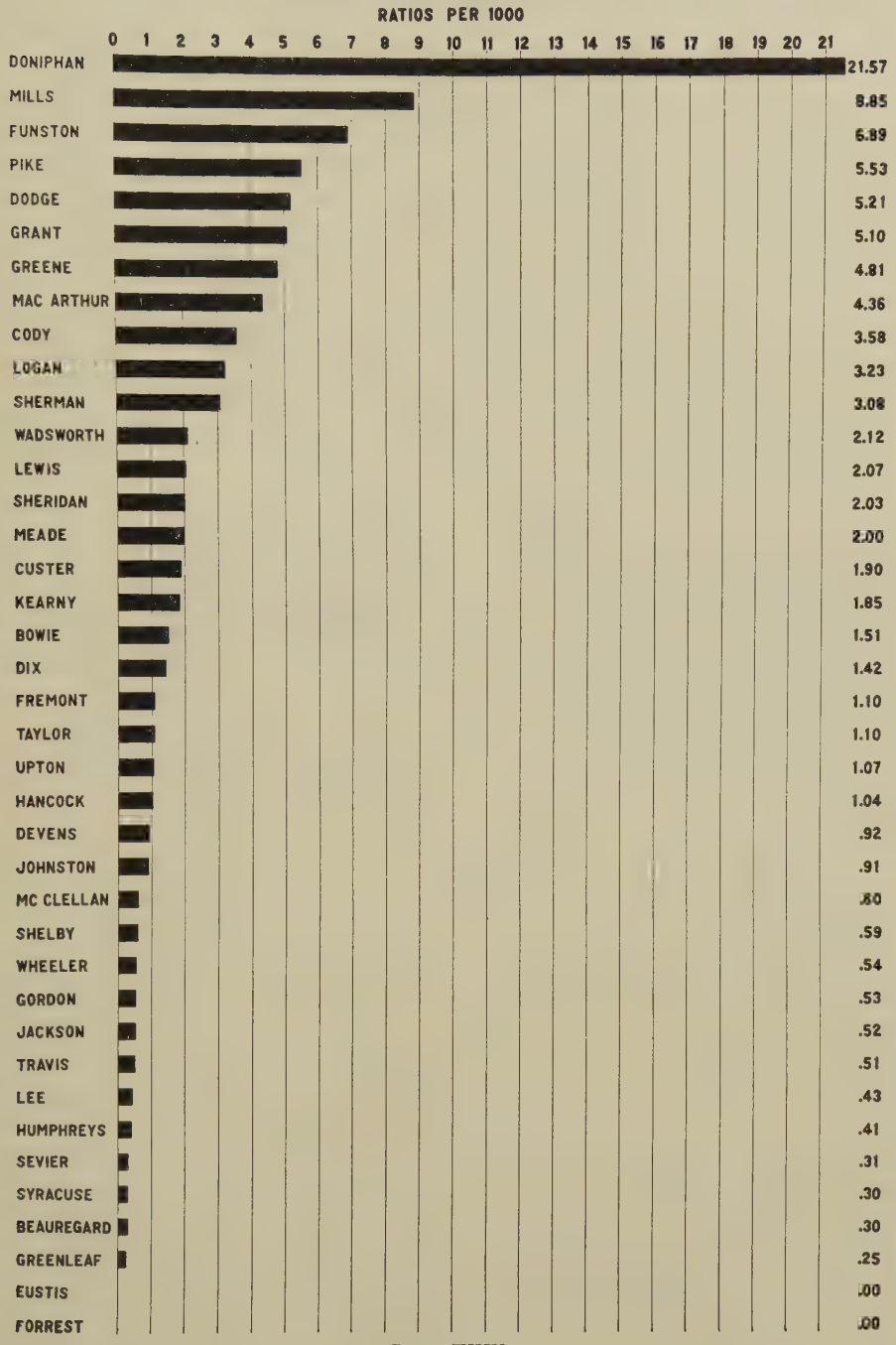

CHART XXXI

56706—28——16

Chart XXXI indicates very clearly that Camp Doniphan, Okla., led all stations in the United States as a diphtheria center. Keefer, Friedberg, and Aronson [1] show that sporadic cases were present through the period October, 1917, to February, 1918, when the admissions increased rapidly; there was a slight fall during the first week of March and then a secondary rise, reaching the highest point during the week ending April 7.

The outbreak studied by these authors covered the period October 7, 1917, to May 31, 1918, and included 461 of the 577 cases occurring between April 15, 1917, and December 31, 1919. The undue prevalence was rather sharply limited to February and March. A careful study was made of carriers and, as might be expected, the carrier rate paralleled the morbidity. As indicated above, the case fatality was low, pointing to low infectivity of the microorganism. A study of occurrence by organizations showed decided

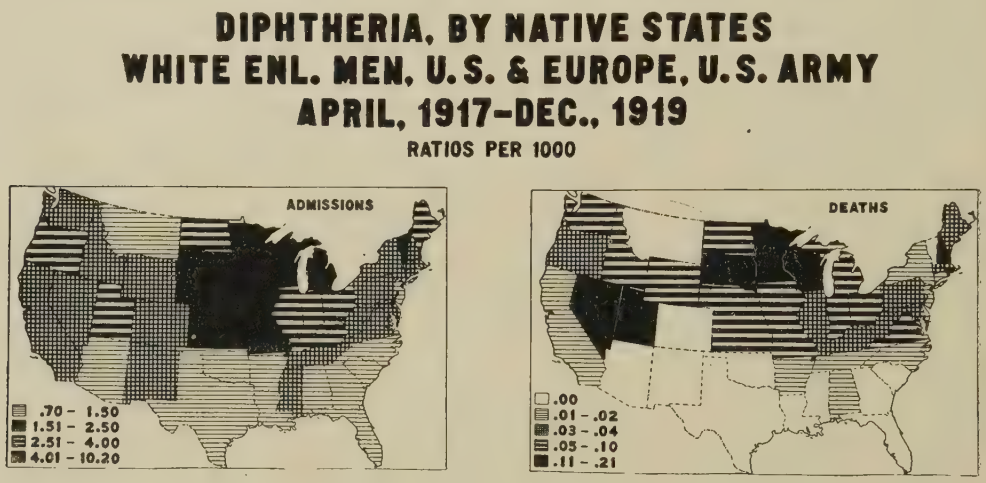

CHART XXXII

resistance on the part of those coming from urban centers, except among hospital personnel, where continued exposure to presumably heavy infection broke down the resistance of urban as well as rural dweller.

In all other camps diphtheria was present, but did not show any alarming increase other than an occasional slight rise in admission rates, with seasonal changes, and the addition of carriers coming with augmented population.

OCCURRENCE IN THE AMERICAN EXPEDITIONARY FORCES

Table 33 shows a total mean annual strength of 1,665,796 in the American Expeditionary Forces, with 4,860 admissions, or an annual rate of 2.92. There were 76 deaths, giving a case fatality of 1.56 per cent, or 15 deaths per 1,000 cases. While the annual admission rate (2.92 per 1,000) is higher than that for troops in the United States (2.63), the period of higher incidence is practically limited to the spring of 1918 and the fall of 1919. The latter period was one of markedly reduced strength, with concentration of troops in the occupied area in Germany, and increased contact with civilian carriers in younger age groups. The rate of incidence was not significant; for example, in December, 1919, there were only 22 cases. Since the strength now had fallen to 18,379, the resultant annual rate for the month (14.36 per 1,000) is high.

Considering diphtheria as a divisional problem, which it properly became in the American Expeditionary Forces, there were only 2 divisions of the total 42 in which the disease became at all alarming. The history of diphtheria in each unit was traced by Neal and Sutton.[2] Both these divisions came from camps in the United States where there was undue prevalence, namely, Camp MacArthur, Tex., and Camp Doniphan, Okla. It is quite reasonable to presume, then, that each division brought its own sources of infection in carriers, and the necessary crowding in trains, transports, and billeting provided increased means of spread.

The two divisions affected were the 32d, which came from Camp MacArthur, Tex., and the 35th, from Camp Doniphan, Okla.

The 32d Division had a constant source of known infection from the time it left camp until it reached its area in France; that is, cases developed in Camp MacArthur just before departure of the division (February 4, 1918); others appeared en route to Camp Merritt, and while in this camp awaiting embarkation. Various units of the division were separated for transportation to Europe. It was well along in April, 1918, before the division was concentrated in its area in France, but the incidence of diphtheria in certain units as they arrived was sufficiently high to demand immediate investigation. Surveys revealed a considerable number of carriers as well as clinical cases. Several units of this division had practically no cases, while among others it reached epidemic proportions.

The division moved into the Alsace sector on May 14, and continued having sporadic cases until about July 18, when the epidemic virtually subsided. The effect of this division's diphtheria is shown in the admission rate for the American Expeditionary Forces during the spring of 1918. (See Table 34.)

The 35th Division had a similar experience to that of the 32d, but less alarming. There were, however, a sufficient number of scattered cases constantly present to demand attention from June to September, 1918. The division left Camp Doniphan about the time the epidemic, previously mentioned, was subsiding. Its subsequent diphtheria indicates, as might be expected, that carriers were present throughout the organization. The disease was quite prevalent during the ocean voyage, and while in England 27 scattered cases were reported for the week ending May 29. The division moved shortly after this date, and on June 5 entrained in France for the American area. Forty-eight hours of close contact followed, and a week later there was a sharp rise in diphtheria admissions. The division finally reached its sector in the Vosges Mountains, and troops were distributed in billets and dugouts. There was less opportunity in this situation for contact and spread, and the morbidity rate declined.

During this same period a field laboratory was assigned to the division, and all contacts were cultured and the Schick test was made on them. The resultant weeding out of carriers, active and passive, was undoubtedly the deciding factor in preventing an epidemic in the organization.

The concentration of American forces for the St. Mihiel and the Meuse-Argonne operations found diphtheria well controlled and no longer a cause for alarm, but now the hospital centers were beginning to feel its presence.[2]

IN HOSPITAL CENTERS

The first hospital center to report an undue prevalence was that at Mesves. One of its units, Base Hospital No. 54, found during the month of October, 1918, that 1 per cent of its admissions was due to diphtheria, and several cases appeared among the hospital personnel. During the first two weeks of November, 1918, 34 cases appeared in the center personnel and 50 per cent were among those on duty at Base Hospital No. 54. The diphtheria prevalence occurred during the last three months of the year, when hospitals were badly overcrowded, the center under discussion averaging 18,000 patients.

In the other centers, the disease was much less prevalent than at Mesves, though quite a number of cases occurred among patients and personnel. Base Hospitals Nos. 25, 26, and 49, Allerey center, reported a number of nurses and orderlies as carriers who had been diagnosed carriers in the United States.

PATHOLOGY

In the vast majority of instances during the World War the characteristic lesion, the false membrane, was located on the fauces. Its extension into the larynx, trachea, and bronchi occurred, although not frequently.

Other changes occurred due to the absorption of diphtheria toxin or mixed infection. An analysis of 20 protocols on file in the Army Medical Museum, Washington, D. C., obtained from diphtheria cases autopsied during the World War, show the following pathological processes: Pleurisy, 5; laryngeal diphtheria or ulceration, 14; tracheal diphtheria, 9; extension into the bronchi, 5; pneumonia, 15; endocarditis, 2; myocarditis, 9; pericarditis, 5; nephritis, 6; hydrothorax, 1; fatty degeneration of the heart muscle, 3; basilar edema, 1; meningitis, 1; gangrene of the tonsils, 1; edema of the glottis, 2; acute splenitis, 7; pneumothorax, 1; bullous emphysema, 2; cloudy swelling of the liver, 8, of the kidney 7, and of the heart, 5; petechial hemorrhage, 4; evidences of gassing, 3; septicemia, 6; urticaria, 1. The blood was examined for diphtheria bacilli four times, all of which were negative. Duration of the disease after admission to hospital varied from 1 to 19 days, with an average of 5. 3 days. The cases of longer duration, generally speaking, showed heart involvement.

Among 4, 500 autopsy reports after pneumonia, the diphtheria bacillus was recovered in five instances, once from the bronchus and four times from the consolidated lung. Among 13, 246 autopsies in the American Expeditionary Forces, 26 were on bodies of diphtheritic cases. A study of these protocols showed that 12 cases died during the acute stage of the disease. Of the others, 11 died from later complications or contributory causes.

SYMPTOMS

Types of the disease by location of the membrane are: Faucial, nasal, laryngeal, bronchial, and wound diphtheria. The records of the War Department do not permit of analysis for the total Army by such types; however, the vast majority of the cases were faucial; for example, at Camp Custer, Mich.,[3] among 55 cases the membrane was situated as follows: Pharynx, 4;

tonsils, 41; tonsils and pharynx, 10; pharynx and larynx, 1; nose, 1. That cases of laryngeal diphtheria, and extension of the process into the trachea, bronchi, and even into the lung tissue itself, occurred is shown by reports of tracheotomy and autopsy protocols; however, the exact number of such cases in the Army is not known. In the severely gassed, pseudo membranes often occurred in the bronchi and trachea which masked the diagnosis of diphtheria.

Depending upon the severity of the disease, diphtheria is arbitrarily divided into the following types: Mild, moderately severe, severe, and malignant. This classification was used by the Army during the World War as a basis upon which to determine the antitoxin dosage. Figures, by types, are not available, but numerous reports, at home and abroad, indicate that the disease in epidemic form was relatively mild, and that though the more severe types occurred, they were in the minority.

COMPLICATIONS, SEQUELÆ, AND CONCURRENT DISEASES

Complications and sequelæ constitute important phases in the clinical course of diphtheria. Among the total 10,909 primary admissions, 2,439 complications were reported, with 107 deaths. The total number of deaths credited to diphtheria among primary admissions is 177. No explanation, other than diphtheria, is found for the cause of death among the remaining 70 cases. The case mortality for the total Army was 1.62 per cent.

The most important early complication was pneumonia. This complication is a frequent cause of death, more especially in the laryngeal form of diphtheria. Usually, it is due to a secondary infection by the pneumococcus or pus organisms. In 162 cases pneumonia was reported as a complication of diphtheria, as follows: Bronchopneumonia, 61; lobar pneumonia, 101. The death rate, however, was far greater among the former. There were 10 deaths, or 9.9 per cent, among the lobar cases and 27, or 44.2 per cent, among the bronchopneumonia cases.

Perhaps the next most important complications were those involving the heart. Of 21 clinical histories of diphtheria on file in the Surgeon General's Office, the cause of death in 4 cases was attributed to pericarditis, in 2, to myocarditis, and in 1 to heart block. The average time in hospital before death was 7 days for cases with pericarditis, 6 days for those with myocarditis, and 6 days for those with heart block.

Neal and Sutton,[2] studying diphtheria in the American Expeditionary Forces, attributed the myocarditis, cardiac paralysis, post-diphtheritic optic paralysis, laryngeal paralysis, and other nerve affections, as well as prolonged convalescence, to inadequate methods of treatment. The clinical histories of 21 men discharged from the service on account of disability following diphtheria show disability to have been due to mitral disease in 2 cases and myocarditis in 1. Tachycardia was noted in 25 of the primary admissions and neurocirculatory asthenia among 14. Among cases in which diphtheria was a concurrent disease, pericarditis was noted in 1, aortic insufficiency in 2, mitral insufficiency in 7, mitral stenosis in 3, myocarditis in 7, tachycardia in 2, and neurocirculatory asthenia in 6.

Among 47 protocols of fatal cases of diphtheria in the Army during the World War, laryngeal paralysis was a cause of death in 5. Of 21 cases discharged from the service on account of disability following diphtheria, there were 11 instances with paralysis of the upper extremity and 12 of the lower. Optic neuritis was a cause of discharge for disability in 9 cases. The cases with paralysis of the extremities also had laryngeal paralysis in 3 instances. One case was discharged from the service on account of facial paralysis and one each for the following conditions: Otitis interna, myocarditis, psychasthenia, and paralysis of deglutition. Among the 2,439 complications of the cases of diphtheria in the Army, paraplegia was present in 3, and other paralyses in 14 cases. Neuritis (without location) was present in 14 instances. No cases of hemiplegia were reported.

Nephritis was an uncommon complication. It was reported in 20 cases, 8 of which were acute and 12 chronic nephritis; that is, 0.81 per cent of the total complications. Among the nephritides there were 4 deaths, 3 of which followed the acute form.

Meningitis is a rare complication. During the war, five cases of meningitis were reported among primary admissions for diphtheria, 2 of which were of the epidemic type. The Klebs-Loeffler bacillus was not recovered from the cerebrospinal system in any of these cases.

Occurrence of diphtheria with the exanthemata is well known and at times offers difficult differentiation, particularly in some cases of scarlet fever. Occurrence with the most important exanthematous diseases during the war was as follows:

Disease	Primary admissions	Complicating diphtheria	
		Cases	Deaths
Measles	98,225	23	0
Scarlet fever	11,675	64	1
Chicken pox	1,757	5	0
German measles	17,378	4	1
Mumps	230,356	90	1
Total	359,391	186	3

DIAGNOSIS

The diagnosis of a typical faucial case is not difficult. The presence of a membrane in the throat of a patient acutely sick should immediately suggest diphtheria, and the case should be observed and dealt with accordingly until this tentative diagnosis has been confirmed by clinical and laboratory means. The onset of diphtheria is acute; locally there is usually a membrane, and the patient is suffering from an acute toxemia. However, other organisms are capable of producing false membranes—pneumococcus, streptococcus, bacillus of Friedlander, and *Bacillus pyocyaneus*. Rarely in diphtheria no membrane is formed. In practice the diagnosis of diphtheria is justifiable, provided the patient is acutely sick, suffering from a membranous sore throat, the microscopical examination of which reveals the presence of an organism morpho-

logically similar to the Klebs-Loeffler bacillus. If the patient has no constitutional symptoms, although diphtheria bacilli are found in the exudates, he is a carrier of a virulent or an avirulent strain, and clinically the case is not one of diphtheria. Theoretically, in order to establish a diagnosis of diphtheria, the patient must have local and general signs of the disease, the diphtheria bacillus must have been isolated from the local lesion in pure culture, it must have been proved to be virulent, and the case must have responded to antitoxin. In practice, virulence tests are reserved for carriers, and antitoxin is used for therapeutic or prophylactic and not for diagnostic purposes on man.

Although the diphtheria bacillus is abundantly present in the local lesion, carelessly taken smears may fail to reveal them; therefore, cultures should be taken with care and from the most suspicious area. Dependence can not be placed upon one negative culture.

Early diagnosis is of the greatest importance, not only for treatment, but in prevention as well. Too much emphasis can not be placed on this, since it was noted during the war, especially in the American Expeditionary Forces, that battalion and regimental surgeons occasionally were reluctant to make a clinical diagnosis of diphtheria;[2] furthermore, some cases occurred on transports returning to the United States where late diagnosis was made and the cases terminated fatally on the day of, or the day after, debarkation in the United States.

Differential diagnosis between diphtheria and follicular tonsillitis, Vincent's angina, scarlet fever, streptococcic sore throat, peritonsillar abscess, and syphilitic ulceration of the mouth is important. In addition to these, cases of retropharyngeal abscess, phlegmon of the glottis, and severe gassing must be carefully examined in order to differentiate from laryngeal diphtheria. Diagnosis based upon careful physical examination and bacteriological examination is possible. In the above-mentioned conditions clinical examination alone may not furnish sufficient data for differential purposes. The fact must also be borne in mind that diphtheria may be engrafted upon one or the other of these conditions, or the case may be in reality a diphtheria carrier and clinically suffering from some other condition. Therefore, a correct diagnosis can be made only by a careful analysis of the physical findings in conjunction with the laboratory report.

During the war, severely gassed cases in whom laryngeal fibrino-purulent membranes were formed strongly resembled diphtheria. Medical officers serving overseas often remarked on the difficulty in differential diagnosis from diphtheria. The membrane in gassed cases, according to Barron and Bigelow,[4] covered the lining of the larynx and trachea and extended from the epiglottis down into the bronchi and bronchioles. The tissues of the ventricles and vocal cords were at times markedly edematous, producing voice changes and mechanical obstructive breathing. This membrane rarely extended up into the larynx or over the tonsils; but nearly all of the serious cases of diphtheria had severe laryngeal manifestations, so that even at autopsy it necessitated close scrutiny to differentiate between laryngeal diphtheria and laryngitis and tracheitis following gassing. Besides, diphtheria was occasionally superimposed upon laryngitis following gassing.

CONTROL AND PREVENTIVE MEASURES

The most important measures for control and prevention of diphtheria are early recognition of cases and carriers and their proper isolation. Frequent inspections of men with sore throat, and culturing them will detect the cases. Not infrequently, cases occur where the symptoms are mild and the throat presents a beefy red appearance with but little membrane. Upon careful examination, pinhead-sized patches may be seen. Such cases usually have an elevated temperature, and are important in the spread of the disease. The wholesale culturing and administration of antitoxin to all those in mediate or immediate contact is a thing of the past in dealing with masses of soldiers. The control of diphtheria is principally the detection and control of diptheria carriers. Nichols [5] makes the statement that in theory the detection and management of carriers have been carried almost to perfection, but in practice the system breaks down because the number of men exposed and the number susceptible are large. Since laboratory and clinical facilities are usually limited, only a certain number of cultures can be examined daily, and a much smaller number of virulence tests made. Furthermore, a limited number of Schick tests can be made daily and several days of observation are needed, while only a few persons can be quarantined and held under observation. The result is, the bacteriological plan of attack fails and common sense must govern. Clinical cases are to be considered first, and as much carrier work done as is feasible.[5]

The Surgeon General, on January 1, 1918, outlined the procedure to be followed in the case of diphtheria.[6] These instructions were briefly as follows: Strict isolation was to be instituted. Male attendants were to be segregated and not allowed to eat or sleep with other members of the medical detachment. Nurses were to be provided with special quarters and messing facilities. When on duty in the wards, all female nurses, male attendants, and medical officers were to wear operating gowns, caps, and gauze masks over the nose and mouth; the hands were to be thoroughly washed and disinfected after coming off duty and before leaving the ward. Cultures were to be taken every fourth day from the personnel on duty in diphtheria wards, and no nurse, officer, or enlisted man was to be assigned to other duty until negative cultures were obtained. The bedding, clothing, etc., of patients and the gowns and caps of attendants were to be thoroughly disinfected by steam or chemicals before going to the laundry; nasal and oral discharges of patients were to be disinfected or burned; dishes, etc., were to be sterilized before being returned to the general kitchen. Diphtheria convalescents and carriers were not to be returned to duty until three consecutive negative cultures, taken at intervals of from three to six days, were obtained. Diphtheria carriers were not to be segregated in the same room with men sick with diphtheria, but in a suitable segregation ward, camp, or barrack. In addition the Schick test was to be applied to nurses and male attendants, and those not immune were to be immunized.

Diphtheria patients were invariably hospitalized; also some of the carriers. When in hospital, they were assigned to special wards where cubicles and masks were used. Weaver[7] claimed that, coincident with the use of the mask, there was an absence of diphtheria and diphtheria carriers among the physicians and nurses of his hospital and only a limited amount of throat infection. At Camp

Sherman, Ohio, before the days of universal masking, it was difficult to obtain a sufficient number of negative cultures of both diphtheria and meningitis patients to permit their release from hospital.[8] At Camp Grant, Ill., experiments were conducted with the mask in contagious wards, and it was concluded that this was a valuable agent in preventing cross infection.[9] Haller and Colwell[10] conducted extensive experiments with varying layers of gauze possessing different-sized fibers and mesh, and showed that about six layers of ordinary gauze should be used. Barron and Bigelow,[4] stated that it was impracticable, of course, to mask all of the 16,000 individuals in the hospital center where they worked, though one hospital of the center tried masking its entire personnel. Cubicles were recommended by them to supplement the masks of the patients, since few could sleep with the mask in place. The original mask had two layers of gauze with a mesh of 14 to 16. It was recommended by them that two such masks be worn, since two thicknesses were insufficient. The personal cooperation of the patients was held to be absolutely essential to individual quarantine.

The following thorough procedure was adopted at Camp Sherman, Ohio, in the control and prevention of diphtheria there:[8]

(*a*) Procedures adopted in line organizations after diagnosis of a case:
- Detection of one or two carriers does not call for quarantine.
- All contacts of the company are segregated (intimate contacts).
- All contacts are Schicked, cultured (nose and throat), and masked.
- Transfer all carriers to hospital for observation and treatment and immunize all those showing positive Schick tests.

(*b*) Procedure in wards where diphtheria appears:
- Where the patient is able to be transferred—
  - Transfer the patient to the diphtheria ward and do not institute quarantine.
  - Examine all close contacts by culture and Schick testing.
  - Mask all personnel and patients of the ward.
  - No patients will be transferred to other wards until the culture is negative.
  - If a case develops among the carriers, then reculture the entire ward.
  - Give prophylactic serum to all with positive skin tests.
- If the patient is too ill to be transferred—
  - Quarantine the entire ward and place the patient in a single room of the ward.
  - Culture and Schick test the entire ward and mask all patients and personnel.
  - Transfer all detected carriers to the carrier ward, if possible; if not, place them in cubicles.
  - Repeat the culturing at two-day intervals.
  - When the patient's condition permits, transfer him to the diphtheria ward.
  - Quarantine is lifted when two negative cultures are received.
- Procedure among suspects sent to hospital—
  - Mask them on entering the ambulance and hold under observation in an observation ward until a diagnosis is made and then make the transfer.

(*c*) Procedure in diphtheria and diphtheria-carrier wards:
- At all times quarantined, cubicle the patients and mask the personnel.
- Keep patients, convalescents, contacts, and carriers segregated by groups.

Several hospitals found it advisable to culture patients on admission, notably the hospitals at the port of embarkation, Hoboken, N. J.[11]

Although toxin-antitoxin mixtures were thought of during the war as a prophylactic measure, this means of conferring immunity was used to a very limited extent. It was not considered a practical war measure on account of the time required for administration and to establish immunity.

TREATMENT

Laryngeal diphtheria, cases seen late for the first time in treatment, and those occurring as a complication of an exanthem, should be regarded as severe and treated accordingly. In severe cases, suspected of being diphtheritic, it is better to give antitoxin and not await the results of laboratory reports, as valuable time may be lost. Cases of death due to anaphylactic shock are so rare that possible death from this cause does not justify withholding antitoxin, even intravenously, where the severity of the disease warrants its administration. However, in cases known to be sensitive to horse serum, desensitization may be attempted. The favorite dose of antitoxin used in the Army was 20,000 units, injected, as one dose, into the buttock. There is no record of desensitization having been used before giving serum during the war. If hypersensitiveness to serum is feared, an hypodermic of adrenalin should be available for immediate injection. This precaution was taken by many medical officers.

A study of many World War protocols shows that antitoxin was often repeated; for example, in one case, in which death occurred 2 days after admission to hospital, 4 injections of 20,000 units each were given, 2 subcutaneously and 2 intravenously. In another, where tracheotomy was performed immediately on admission to hospital, 30,000 units were given intravenously. As stated above, several cases were transferred from transports, upon arrival in the United States, and died soon after debarkation from laryngeal diphtheria. In some of these cases 50,000 units or more were given.

Tracheotomy was not an uncommon form of treatment in laryngeal diphtheria in the Army. The low operation was the one of preference. However, so far as the available data show, all cases died; these cases were seen late and irreparable damage was done before treatment was commenced.

The O'Dwyer intubation sets were freely distributed during the war, but there is no record of intubation having been performed.

As regards the treatment of serum sickness in diphtheria, this differs in no way from that occurring in any other disease. It usually appears a week or 10 days after serum administration and responds immediately to hypodermic use of adrenalin. Since this response is of short duration, however, the intense itching is relieved only temporarily; therefore a saline purgative should be given, which usually reduces the intensity of symptoms. This condition is of short duration and commonly borne by soldiers without treatment. There is no discoverable record of sudden death occurring in the Army during the war following the use of serum in any form.

TABLE 36.—*Diphtheria carriers. Admissions, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919, inclusive, absolute numbers and annual ratios per 1,000*

	Total mean annual strengths	Admissions		Discharges for disability		Days lost	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Noneffective ratios per 1,000 strength
Total officers and enlisted men, including native troops	4,128,479	5,043	1.22	9	0	98,579	0.07
Total officers and enlisted men, American troops	4,092,457	5,041	1.23	9	0	98,383	.07
Total officers	206,382	112	.54			1,163	.02
Total American troops:							
White	3,599,527	4,634	1.29	8	0	91,147	.07
Colored	286,548	99	.35			2,127	.02
Color not stated		196		1		4,126	
Total	3,886,075	4,929	1.27	9	0	97,400	.07
Total native troops (enlisted)	36,022	2	.06			16	.00
Total Army in the United States (including Alaska):							
Officers	124,266	80	.64			665	.01
White enlisted	1,965,297	2,957	1.50	8	0	49,235	.07
Colored enlisted	145,826	76	.52			1,264	.02
Total enlisted	2,111,123	3,033	1.44	8	0	50,499	.07
Total officers and men	2,235,389	3,113	1.39	8	0	51,164	.06
U. S. Army in Europe, excluding Russia:							
Officers	73,728	32	.43			498	.02
White enlisted	1,469,656	1,661	1.13			41,624	.08
Colored enlisted	122,412	22	.18			848	.02
Color not stated		195		1		4,116	
Total enlisted	1,592,068	1,878	1.18	1	0	46,588	.08
Total officers and men	1,665,796	1,910	1.15	1	0	47,086	.08
U. S. Army in Philippines Islands:							
White enlisted	16,995	1	.06			8	.00
Colored enlisted	4,456					14	.01
Total enlisted	21,451	1	.05			22	.00
U. S. Army in other countries:							
White enlisted [a]		10				170	
Color not stated		1				10	
Total	14,232	11	.77			180	.03
Transports:							
White enlisted	97,498	5	.05			110	.00
Colored enlisted	10,535	1	.09			1	.00
Total	108,033	6	.06			111	.00
Native troops enlisted: Philippine Scouts	18,576	2	.11			16	.00

[a] Separate strength of white and colored not available.

CARRIERS

Only carriers who were admitted to hospital were reported to the War Department; therefore no record was made of those kept in quarantine areas except when under hospital jurisdiction. This being so, it is impossible to estimate the number of carriers detected in the Army during the World War, since various camps used their own methods of control. Table 36 shows the number of primary admissions to hospital for diphtheria carriers. There were 5,043 such admissions for the total Army, the total mean annual strength being 4,128,479 men. The ratio per 1,000 per annum was 1.22. Officers contributed 112 primary admissions, a ratio of 0.54, and enlisted men the remaining 4,929, which gave an annual admission ratio per 1,000 strength of 1.27 for the latter. The carrier state was not common among colored troops; only 99 primary admissions were reported for colored troops against 4,634 for white troops. The ratios per 1,000 were 0.35 and 1.29, respectively. The number of carriers among native enlisted troops was negligible, there being but two reported.

In the United States there were 3,113 primary admissions for the Army, with a ratio of 1.39 per 1,000 per annum; in the American Expeditionary Forces there were 1,910, with a ratio of 1.15. Despite these figures, it is not believed that there were more carriers among the troops in the United States than in Europe. Culturing was as extensively carried out abroad as in the United States, but the difference essentially is, more carriers were admitted to hospital at home than abroad. This was primarily due to the fact that relatively more bed space was available in the hospitals in the United States than in the American Expeditionary Forces. Carriers, not being sick, could be cared for as well in isolation camps as in hospital. This method was used extensively abroad. Carriers undoubtedly existed on transports, but it was neither practicable nor advisable to undertake any extended search for their detection. There were but six primary admissions on transports for carrier state.

As would be expected, there were no deaths from this cause. Nine cases were discharged from the service for disability on account of a chronic carrier state, eight of which were among white enlisted men and one color not stated.

Noneffectiveness caused by carriers was of considerable importance. For primary admissions to hospitals, Table 36 shows a loss of 98,579 days from duty, giving a noneffective ratio per 1,000 per annum of 0.07. Of the total number of days lost, white enlisted men where responsible for 91,147 days and colored 2,127. The remaining days were among soldiers where color was not stated. Time lost in the United States amounted to 51,164 days and in Europe to 47,086 days. The noneffective ratio in the United States was 0.06 and in Europe 0.08. In other words, cases admitted to hospital in the American Expeditionary Forces remained absent from duty over a longer period than for the primary admissions in the United States. The average number of days of hospitalization per case in the United States was 16.43 and in Europe 24.64.

Table 37 shows primary admissions for white and colored troops, respectively, in the United States and Europe, by months of occurrence; also the ratios per 1,000 per annum. As before stated, it is seen from this table that the number of cases reported was greater in the United States than in Europe; however, during the latter half of 1918, and for a like period in 1919, the conditions were reversed. This is accounted for by the increase in the diphtheria rate for the army of occupation on the Rhine.

TABLE 37.—*Diphtheria carriers. Admissions, by months, white and colored enlisted men, United States and Europe, April 1, 1917, to December 31, 1919, absolute numbers and annual ratios per 1,000*

	White enlisted men						Colored enlisted men					
	United States			Europe			United States			Europe		
	Mean strength	Absolute numbers	Ratios per 1,000 strength	Mean strength	Absolute numbers	Ratios per 1,000 strength	Mean strength	Absolute numbers	Ratios per 1,000 strength	Mean strength	Absolute numbers	Ratios per 1,000 strength
1917												
April	183,758	1	0.07				4,870					
May	245,454			626			5,826					
June	309,205			12,794			5,171					
July	458,817			28,821	5	2.08	6,675					
August	562,714			50,882	3	.71	8,519					
September	776,466	8	.12	70,266	2	.34	9,409					
October	1,032,244	28	.33	92,139			21,795			935		
November	1,061,422	131	1.48	123,429			39,225	1	0.31	2,392		
December	1,129,065	84	.89	160,178			36,851	14	4.56	5,346		
Total, 1917	479,929	252	.53	44,928	10	.22	11,529	15	1.30	723		
1918												
January	1,096,434	232	2.54	193,264			50,705	2	.47	8,673		
February	1,095,039	351	3.85	223,130	15	.81	49,955	6	1.44	9,664		
March	1,129,223	341	3.62	283,268	181	7.67	54,814	2	.44	11,541		
April	1,168,558	250	2.57	388,048	80	2.47	59,015	4	.81	12,667		
May	1,197,757	166	1.66	587,240	77	1.57	87,650	3	.41	28,279	1	0.42
June	1,303,746	104	.96	796,427	79	1.19	89,305	4	.54	33,208	3	1.08
July	1,328,513	64	.58	1,063,192	110	1.24	124,976	1	.10	47,171	1	.25
August	1,284,247	91	.85	1,266,592	152	1.44	168,422	2	.14	78,734		
September	1,321,440	64	.58	1,527,793	74	.58	164,846	6	.44	91,270	1	.13
October	1,343,933	37	.33	1,635,321	77	.57	182,705	1	.07	138,827	1	.09
November	1,255,195	49	.47	1,682,836	143	1.02	150,587	5	.40	148,679	2	.16
December	941,219	239	3.05	1,591,962	138	1.04	104,140	8	.92	148,372	10	.81
Total, 1918	1,205,442	1,988	1.65	936,589	1,126	1.20	107,260	44	.41	63,090	19	.30
1919												
January	672,937	107	1.91	1,488,683	86	.69	68,337	3	.53	140,396	1	.09
February	471,815	113	2.87	1,310,083	99	.91	66,104	1	.18	131,219	2	.18
March	406,839	137	4.04	1,115,693	98	1.05	44,634	9	2.42	123,152		
April	339,836	155	5.47	853,425	42	.59	29,824			119,801		
May	291,810	89	3.66	569,842	40	.84	20,780	1	.58	108,650		
June	246,903	49	2.38	271,633	30	1.33	18,562	1	.65	64,166		
July	215,104	11	.61	111,634	17	1.83	20,058			12,508		
August	156,791	6	.46	48,006	9	2.25	18,013			1,741		
September	149,360	15	1.21	30,315	1	.40	11,322	1	1.06	1,287		
October	139,877	22	1.89	21,055	3	1.71	9,084	1	1.32	185		
November	132,403	5	.45	18,920	66	41.85	8,792			83		
December	135,441	8	.71	18,379	20	13.05	8,935					
Total, 1919	279,926	717	2.56	488,139	511	1.05	27,037	17	.63	58,599	3	.05
Month not stated					14							
Total for period	1,965,297	2,957	1.50	1,469,656	1,661	1.13	145,826	76	.52	122,412	22	.18

The number of carriers reported by months shows a distinct seasonal occurrence, which reached its height during the colder months of the year. This is not true in so far as colored troops were concerned, among whom the cases reported were only sporadic. The trend is better brought out by the reports of primary admissions of carriers in the United States.

In addition to the 5,043 primary admissions, the carrier state was reported 2,359 times as a concurrent condition. This makes a total of 7,402 carriers reported as patients. It is not believed, however, that 2,359 represents the total number of carriers detected among patients during extensive outbreaks of diphtheria in our large hospital centers oversea; numerous carriers were detected, the rush of work preventing recording all such cases.

At Camp Custer, Mich., Blanton and Burhans[3] found 148 carriers among 8,236 soldiers examined, or 1.8 per cent. McCord, Friedlander, and Walker[8] found 89 contact carriers among 3,215 soldiers at Camp Sherman, Ohio, or 2.76 per cent. Keefer, Friedberg, and Aronson[1] reported 686 carriers among about 30,000 men cultured at Camp Doniphan. The most extensive report on the detection of carriers is that of Schorer and Ruddock[11] from the embarkation and debarkation hospitals, New York City. There, on account of the extensive occurrence of diphtheria, routine culturing of all patients admitted to hospital was deemed necessary. Table 38 shows the results of some 50,000 admissions of soldier patients arriving on transports at this port.

TABLE 38.—*Results of cultures for the detection of diphtheria bacilli among soldiers arriving at the port of Hoboken on transports, December, 1918, to May, 1919*

Month	Debarkation Hospital No. 3			Debarkation Hospital No. 5			Debarkation Hospital No. 2			Embarkation Hospital No. 4		
	Patients	Positive	Per cent	Patients	Positive	Per cent	Patients	Positive	Per cent	Patients	Positive	Per cent
December	4,482	34	.76	810	14	1.73	2,261	60	2.65	384	2	0.52
January	2,958	37	1.22	1,442	19	1.32	2,033	59	2.41	278	2	.72
February	3,198	51	1.59	2,958	45	1.52	1,128	17	1.51	425	1	.24
March	5,651	70	1.23	5,473	61	1.11	1,108	5	.45	294	1	.34
April	8,520	81	.95	4,047	32	.79				438	1	.23
May	2,378	19	.80							229	1	.44
Total	27,187	292	1.07	14,730	171	1.15	6,530	141	2.16	2,048	8	.39

Grand total: Patients, 50,495; positive, 612; per cent, 1.21.

Table 38 shows that the percentage of positive cultures varied from 0.39 to 2.16. Debarkation Hospital No. 2 served largely as a contagious hospital, Embarkation Hospital No. 4 for officers and nurses, while Debarkation Hospitals Nos. 3 and 5 were used for general enlisted men's debarkation hospitals. The percentage for December, 1918, and January, February, and March, 1919, was higher than during the following April and May. While 1.2 per cent of positive cultures is not high, yet the actual number, 612, is large when the short period of time and the actual number of exposures are considered. Table 39 shows the relationship between carriers and clinical cases in Debarkation Hospital No. 3.

TABLE 39.—*Diphtheria carriers and clinical cases of diphtheria, relative occurrence, at Debarkation Hospital No. 3, New York, December, 1918, to May, 1919*

Month	Admissions (total)	Carriers	Clinical cases
1918:			
December	4,482	34	2
1919:			
January	2,958	37	13
February	3,198	51	20
March	5,651	70	30
April	8,520	81	17
May 1–15	2,378	19	15

In the American Expeditionary Forces, as well as in the United States, the diphtheria carrier was a serious problem in preventive medicine; however,

routine culturing of line organizations was not considered practical or necessary. Upon the appearance of diphtheria, contacts were examined for the detection of carriers. Messmates, soldiers of the same sleeping quarters (more especially those whose beds were adjacent), and members of drill squads were considered contacts for quarantine and culture purposes. The search for carriers in hospitals was usually confined to patients and personnel of the ward where cases occurred; but in some instances the disease was so widespread that it necessitated examination of many wards. Reappearance of cases necessitated a second, or further, culturing for carriers. In Base Hospitals Nos. 25, 26, and 45 of the Allerey hospital center, several nurses and enlisted men of the Medical Department were detected as carriers who were known to be carriers in the United States before departure for overseas, but had been released upon the report of three negative cultures.[2] In Base Hospital No. 25, 75 carriers were found, 33⅓ per cent of whom gave histories of having been gassed. Since the incubator space was limited to 2,000 cultures per day, entire hospital centers were not cultured. It was remarked that it would require about eight days to culture the population of the Allerey hospital center, which approximated 16,000 persons.[2] Such delay would have resulted in the loss of much of the benefit of extensive control measures. Some 13,000 cultures were made on selected cases. Carriers in the Savenay hospital center offered the same problem of control.[2]

Direct or indirect contact with one harboring the organism is necessary for the development of a carrier. If the strain with which the individual becomes infected is an avirulent one, or if virulent and the individual is immune, a carrier state results. Enlarged or diseased tonsils have been shown to harbor the germs with great tenacity. The presence of excessive lymphoid tissue in the nasopharynx, atrophic rhinitis, hypertrophied turbinates, deflected nasal septum, or any chronic condition that interferes with nasal ventilation predisposes the individual. Empyema of the accessory nasal sinuses and open suppurating wounds of all kinds, at times, show the presence of virulent or avirulent diphtheria bacilli. Like the disease itself, diphtheria carriers are more common during the colder months when respiratory diseases are most prevalent. Judging from our experience during the World War, carriers are much more common among white persons of the soldier age than among colored. Weaver and Murchie [12] cultured the hands of internes and nurses, also door knobs of the hospital, for the purpose of showing what part they played in the spread of diphtheria. Hemolytic streptococci were also looked for during these examinations. The technique was that commonly used in isolating these organisms; virulence and antitoxic immunization tests were also used. Of the persons examined, who came in contact with diphtheria patients, a total of 268 examinations were made by taking smears from under the fingernails and from the palmar surface of the right index finger. Of these 9.3 per cent showed the *Streptococcus hemolyticus* and 3 per cent the diphtheria bacillus. Of 45 nurses, 35.6 per cent showed the streptococcus and 13.3 per cent the diphtheria bacillus. Among 51 cultures made from graduate nurses, specially trained in the care of diphtheria patients and actually engaged in this work, 2 per cent showed the *Streptococcus hemolyticus* and none the diphtheria bacillus. Of 45 cultures made from 3 internes,

15.6 per cent yielded the *Streptococcus hemolyticus* and 6.7 per cent the diphtheria bacillus. Each of the three internes showed the diphtheria bacillus on one occasion after ordinary washing. It was recovered after autopsy on a diphtheria case where no rubber gloves were worn. Cultures were also made from the door knobs in 137 instances. The *Streptococcus hemolyticus* was found in 5.8 per cent and the diphtheria bacillus in 4.4 per cent. All of the above examinations were made after ordinary washing with soap and water. Barron and Bigelow [4] made 522 cultures from the hands of patients, and from fomites in wards containing diphtheria as well as in wards where no diphtheria was reported. This was done for the purpose of showing the value and danger of the face mask in the spread of diphtheria bacilli. The following is a summary of this work:

	Per cent
Exposed wards:	
Typical *B. diphtheriæ*—	
On "masked" hands	6.3
On "masked" fomites	8.1
Typical *B. diphtheriæ*—	
On "unmasked" hands	16.1
On "unmasked" fomites	4.9
Atypical *B. diphtheriæ*—	
On "masked" hands	6.3
On "masked" fomites	11.7
Exposed wards—Continued.	
Atypical *B. diphtheriæ*—	
On "unmasked" hands	14.9
On "unmasked" fomites	7.4
Unexposed wards:	
Atypical *B. diphtheriæ*—	
On "unmasked" hands	5.9
On "unmasked" fomites	5.0

"Exposed wards" were wards in which clinical cases of diphtheria or carriers were treated; "unexposed wards" were wards in which no cases of diphtheria or carriers had been found. The term "masked" means that the patient whose hands or fomites were cultured wore a mask, while " unmasked" means, conversely, that he wore no mask. Typical diphtheria bacilli were found nearly three times as often upon the hands of those not wearing masks as upon those wearing them.

TECHNIQUE OF EXAMINATION FOR CARRIERS

The detection of carriers bacteriologically requires the same technique as in the search for cases; however, the taking of specimens differs. In the former, there is usually no acute pathological process as a guide to the most probable site where the organisms may be found and found in great preponderance. In routine culturing for carriers a sterile swab is pressed and passed firmly over the faucial surfaces, particular attention being paid to the tonsils. The swab is then stroked over the surface of a blood serum slant which is incubated and later examined as in the detection of cases. Additional swabs, made from the nasal passages, increase the percentage of positive cultures. Both faucial and nasal smears may be made on the same slant. This method was used in some instances, especially at Camp Doniphan, Okla.,[1] although it may be said that most medical officers were content with the faucial specimen, except in selected carriers where the carrier state became chronic and the focus of infection was sought for.

It was emphasized by medical officers repeatedly during the war that single cultures, irrespective of the technique used, would reveal only a portion of the carriers. The percentage varies between wide limits. Among healthy

persons of various ages, single cultures show from 1 to 30 per cent to be carriers, with an average of 3 to 4 per cent, and probably reveal less than one-half of the persons infected. As regards the pathology of chronic carriers, Nichols[5] states that among incubationary carriers the bacilli are found in large numbers at the site of the common lesion; in contact carriers nothing specific is found, and among chronic convalescent carriers the tonsil is by far the most common focus of infection. Occasionally, however, the organisms are found in sinuses or in adenoid tissue. There is no local inflammatory reaction with an outpouring of exudate into the tonsillar crypts; therefore the organisms are not easily detected.

Keefer, Friedberg, and Aronson,[1] reporting 294 patients at Camp Doniphan, Okla., where the tonsils were removed to relieve the carrier state, found 57 per cent positive and 43 per cent negative in cultures made from the tonsil immediately preceding the operation. Cultures of the tonsils made after tonsillectomy gave positive results in 77.2 per cent. They concluded that 22.8 per cent of the cultures were negative and emphasize the importance of not relying upon a single examination. Blood cultures were made by them from 43 contact throat carriers, 9 convalescent throat carriers, 3 wound carriers, and 2 wound cases. All were sterile except 1 and that may have been a skin contamination. Urine cultures were made from centrifugalized specimens of 26 carriers and all were negative. The feces were negative in all of 21 carriers examined. Simmons, Wearn, and Williams[13] examined the blood of 25 carriers for isohemagglutinins, according to the Moss classification, with the following results: Group 1, 4 per cent; group 2, 24 per cent; group 3, 12 per cent, and group 4, 60 per cent.

Virulence is the most important factor as a guide to subsequent management. If the carrier is an early convalescent or a contact one, no virulence test is necessary, as most of these strains are virulent; but if the carrier state is a long or doubtful one, then virulence tests are indicated. As to retesting for virulence, this is not necessary, since avirulent strains never acquire virulence and virulent strains retain their virulence with great tenacity.

Although about 10 per cent of chronic carriers are found to harbor virulent organisms, those who have not been in contact with cases do not seem to be of importance. At camp Custer, Mich., among 148 carriers found, 24 strains were recovered and tested for virulence on guinea pigs.[3] Of these 88 per cent were avirulent. Simmons, Wearn, and Williams,[13] reporting on the virulence of 52 strains among throat and wound carriers, state that the percentage among contact throat carriers was 48.1 per cent, and from canvalescent throat carriers 84.6 per cent. Blanton and Burhans[3] expressed the opinion that too much reliance is probably placed on the so-called "virulence tests."

Duration of the carrier state is either short or prolonged, lasting from a few days to months or years. The average period of hospitalization for carriers, previously admitted to hospital for this condition, was 19.54 days. In the United States the average was 16.43 and in the American Expeditionary Forces, 26.04 days. When analyzed more in detail, it is seen that the duration varied between wide limits. At Camp Custer, Mich., the average number of days in hospital among 148 carriers was 11.7 days.[3] At Camp Doniphan,

Okla., it was arbitrarily assumed that the carrier state, among patients convalescing from diphtheria, commenced at the end of the third week of the disease, since the average case becomes bacteria free at that time.[1] It was found that 91.3 per cent of convalescent carriers became baccillus free at the end of the second week following tonsillectomy, among 294 carriers operated upon. The length of time required for the carrier state to end in the debarkation and embarkation hospitals, New York City,[11] is shown in Table 40.

TABLE 40.—*Diphtheria carriers. Duration of carrier state, embarkation and debarkation hospitals, New York. Absolute numbers and average periods of hospitalization by 10-day groupings*

	Number of carriers	Period of hospitalization									Grand average in days
		Less than 10 days			10 to 20 days			20 days or longer			
		Number	Per cent	Average number of days	Number	Per cent	Average number of days	Number	Per cent	Average number of days	
Hospital Ship O'Reilly	65	30	46.1	7.8	24	36.9	12.9	11	18.3	22.7	12.2
Debarkation Hospital No. 1	100	42	42.0	6.8	35	35.0	13.7	23	2.3	28.7	10.94
Debarkation Hospital No. 3	276	178	64.2	5.1	74	26.7	12.7	15	5.4	24.4	8.0
Debarkation Hospital No. 5	36	32	88.8	7.0	3	8.5	15.3	1	2.3	22.0	8.1
Embarkation Hospital No. 4	66	59	89.4	8.4	7	10.5	11.8				8.8

This table includes 543 carriers tabulated by hospital and subdivided into 3 classes as follows: Less than 10 days; 10 to 20 days; and 30 days or longer. It is seen that the averages varied from 8.0 to 12.2 days. There were some chronic carriers in all of these hospitals, but officers and nurses cleared up quickly. The majority were only temporary carriers. On the hospital ship *O'Reilly* only 12 per cent cleared up in 12 days or less as compared with the results of Embarkation Hospital No. 2, where, among 270 carriers, but 9 had to remain in isolation for more than 3 days.

As to the handling of diphtheria carriers, during the earlier months of the war practically all such carriers in the United States were hospitalized, their presence being looked upon with grave apprehension. As time went on, however, and space in hospitals became less available, it became the practice to isolate carriers (except incubationary and convalescent) in barracks or tent areas especially set aside for the purpose. Incubationary and convalescent carriers continued to be cared for in hospital. As soon as practicable after being quarantined, each carrier was given the Schick test. Contact and chronic carriers showing positive skin tests were immunized, generally with 1,000 units of antitoxin. In rare instances a toxin-antitoxin mixture was used. Pseudocarriers were released as soon as detected. If a carrier state was a prolonged one, it was often shortened by transfer to hospital for tonsillectomy or virulence testing. In hospitals, carriers were assigned to wards where cubicles and masks were used; in barracks, improvised cubicles were used. The quarantine of contacts was considerably shortened by the use of throat cultures and the Schick test. It was considered safe to release carriers 24 hours after all susceptibles had been immunized.

TREATMENT OF CARRIERS

Various chemicals were used locally to clear up carriers. Tincture of iodine seems to have been the favorite. Diphtheria antitoxin was used locally and by injection without success. The only local measure that seems to have met with general favor was tonsillectomy. At Camp Sherman, Ohio, tonsillectomy was performed on a number of cases with prompt results.[8] Of the 294 carriers treated by tonsillectomy, reported by Keefer, Friedberg, and Aronson, 32 per cent had no further positive cultures, while 46.4 per cent were negative at the end of one week, and 91.3 per cent negative at the end of the second week. Striking results were seen after tonsillectomy at Camp Custer.[3] The consensus of opinion of medical officers seems to have been that in chronic carriers where diphtheria bacilli were located in the tonsils, by far the best form of treatment is tonsillectomy. This method of treatment could not be expected to produce favorable results if there were foci of diphtheria bacillus infection elsewhere. Other than this, it may be said that local treatment was, in general, ineffective in relieving the carrier state.

Briefly, it may be said that carriers of avirulent organisms are harmless and attemps were made to isolate only carriers of virulent bacilli. Appropriate treatment, depending upon the kind of carrier, was given. For release from quarantine, three consecutive negative cultures, without treatment, at daily intervals, or on alternate days, were required. A long protracted isolation was not looked upon with favor unless the organism was a virulent one.

WOUND DIPHTHERIA

Diphtheria bacilli are capable of producing a false membrane in wounds. These organisms may exist alone or associated, and it appears that no variety of wound is immune. Wound diphtheria has been reported as complicating empyema wounds, chronic suppurating wounds in general, especially such as amputations, burns, bites, blisters, contusions following gunshot injuries, compound fractures. Though there is usually a false membrane, diphtheria infection has been found where no membrane was present. This, however, is the exception. There is usually a fetid, offensive odor, which, too, may be absent. All authors reporting on this subject apparently agree that the diagnosis of wound diphtheria can not be made with certainty upon clinical grounds alone; nevertheless, any unusual appearance in a surgical wound should lead to a bacteriological examination of the discharge; and if an organism is found that resembles diphtheria morphologically or culturally, virulence tests are called for. By this method it can be determined whether the wound infection is really of a diphtheritic nature or not. In the diagnosis of suspicious wounds, where cultures made from surface smears are negative, curettement should be done and smears taken from a deeper layer.

Hartsell and Morris[14] reported upon 60 cases of wound diphtheria in the Army during the World War. In none of these wounds were there any systemic symptoms referable to diphtheria toxin. The clinical appearance of the wound varied; that is to say, 12 per cent showed the grayish membrane typical of diphtheria; one-half showed only a faint grayish discoloration of the granulating surfaces; about 6 per cent looked absolutely healthy and ready for

secondary closure. So far as could be observed, the presence of diphtheria bacilli in the wound had no effect upon healing. The Schick test was performed on 43 patients, 6 being positive. The response to treatment varied. In some cases the diphtheria bacilli disappeared 2 days after treatment, while in others they were very resistant, ranging to 49 days. By far the most efficient treatment was tincture of iodine. With this treatment, 15 cases cleared up under 48 hours, and only 11 cases remained positive longer than a week. Antitoxin, in 4 doses of 20,000 units each, was given in 4 cases, but had no effect on ridding the wound of the bacillus. Antitoxin as a wet dressing was also used in two cases without effect. Acetic acid, cauterization, and Carrel-Dakin solution were used without effect.

Keefer, Friedberg, and Aronson, reported an epidemic of wound diphtheria in two wards of the base hospital at Camp Doniphan, Okla., where rib resections had been made on account of empyema. Between March and May, 1918, 40 cases occurred. In 33 cases the diphtheria bacillus was found in the wound, while in 12 it occurred both in the throat and wound of the same individual. Simmons, Wearn, and Williams[13] reported diphtheria infections with particular reference to carriers, and wound infection with diphtheria bacilli at the Walter Reed General Hospital, Washington. They reported that 42 per cent of the strains from wound carriers were very virulent, while 80 per cent of those from wound cases were very virulent. Neither morphology, fermentation reactions, nor cultural characteristics gave any indication of the degree of virulence of the organism studied.

Simmons and Bigelow,[14] reporting on diphtheria bacilli in postoperative empyema wounds from the laboratory of the Southern Department at Fort Sam Houston, Tex., found an organism morphologically like the diphtheria bacillus in 60 healing cases. Of the organisms isolated, 17.8 per cent were virulent for guinea pigs, and all of these strains failed to produce acid when grown on saccharose broth for eight days. However, the degree of virulence of sugar negative strains was variable. The morphologic characteristics of virulent and avirulent strains were the same and all cultures contained a mixture of Westbrook's types A, C and D with subtypes. They found no evidence of the development of specific agglutinins, precipitins, or complement fixation substances for diphtheria bacilli in the serum of infected individuals. Apparently, there is no invasion of the blood stream by the diphtheria bacillus in wound cases. All methods of treatment proved unsatisfactory, due probably to the growth of the bacilli deep in the granulations.

The extent of wound diphtheria in the American Expeditionary Forces is not known. Barron and Bigelow [4] reported its presence at the Allerey hospital center, but the number of cases was not given by them. As a primary admission, wound diphtheria was not tabulated on the Army's list of diagnoses; therefore, the total number of cases can not be determined.

The specific treatment of wound diphtheria is that of faucial diphtheria. The treatment of wound carriers is as unsatisfactory as that of throat carriers. Antitoxin, both local and by injection, has been used without satisfactory results for carriers. The unsatisfactory results obtained from local treatment are probably explained by the deep situation of the bacilli. In the work of Simmons, Wearn, and Williams,[13] all methods of treatment proved to be unsatisfactory, and, as a rule, the carrier state continued until complete healing of the wound had taken place.

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CHAPTER VII

THE VENEREAL DISEASES[a]

STATISTICAL CONSIDERATIONS

That venereal diseases were responsible for great noneffectiveness and economic waste to the Army during the World War is shown by the fact that, of the total primary admissions to sick report on account of diseases only, numbering 3,500,000, venereal diseases were the direct causes in 357,969 admissions, or 10.2 per cent of the whole. If to this number be added cases reported as concurrent with other diseases, the total reported venereal incidence would be 383,706.

For admission to hospital, solely on account of venereal disease, there was a loss of 6,804,818 days from duty. Loss to the service is not entirely represented in the above figure, principally due to the fact that it was the practice to return men to their organizations and to a duty status as soon as their physical conditions would permit, further treatment being carried on in the organization while the soldier was on duty status. Inevitably time was lost for treatment, but was not officially charged as such; and in the case of salvarsan treatment for syphilis, carried out during convalescence, more especially in the United States, men were returned to the hospital or dispensary at regular intervals as out-patients, treated and sent back to their organizations, usually with a loss of about one-half day per case.

Venereal diseases, as a class, stood second among the most common diseases as a cause of admission to sick report for the Army as a whole, and exceeded the total number of men killed and wounded in action by approximately 100,000. As a cause of loss of time from duty, disregarding the additional time unaccounted for, as explained above, the venereal diseases stood second only to influenza, the greatest scourge of the war.

As a cause of permanent disability, requiring discharge from the service, venereal diseases ranked fourth among the most common diseases, being exceeded in this respect by, first, tuberculosis, (5.52), second, valvular heart disease (2.59), third, mental deficiency (2.58). For venereal diseases (2.53), the discharge rate was 49.4 per 1,000 strength for total diseases.

There was a marked difference in the discharge rates for white and colored enlisted men, as shown in Table 41. The former had a rate of 1.41 and the latter 18.36 per 1,000 per annum. The highest rate for any troops in the entire Army and serving in any country was 35.57 for colored enlisted men serving in the United States. The highest admission rate for American enlisted men was among the 21,000 stationed in the Philippine Islands. The rate was 192.12 per 1,000 strength. The second highest admission rate for enlisted men was in the United States (134.33) and the lowest in Europe (34.64).

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

The admission rate for the total Army during the war period was 86.71, based upon total primary admissions. Venereal diseases were approximately five times more common among colored than among white enlisted men. Among the former there were 95,026 primary admissions (331.62), as compared with 250,597 (69.62) among the latter.

TABLE 41.—*Venereal diseases (all). Primary admissions, deaths, discharges for disability, and noneffectiveness, officers and enlisted men, United States Army, by countries of occurrence, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

	Total mean annual strengths	Admissions		Deaths		Discharge for disability		Noneffectiveness	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Days lost	Ratios per 1,000 strength
Officers and enlisted men including native troops	4,128,479	357,969	86.71	173	0.04	10,450	2.53	6,804,818	4.52
Total officers and enlisted men, American troops	4,092,457	356,151	87.02	170	.04	10,422	2.55	6,761,087	4.53
Total officers	206,382	3,300	15.99	5	.02	43	.21	105,957	1.41
Total enlisted men, American troops:									
White	3,599,527	250,597	69.62	106	.03	5,085	1.41	5,208,880	3.96
Colored	286,548	95,026	331.62	56	.20	5,261	18.36	1,323,424	12.65
Color not stated		7,228		3		33		122,826	
Total	3,886,075	352,851	90.79	165	.04	10,379	2.67	6,655,130	4.69
Total native troops	36,022	1,818	50.46	3	.08	28	.78	43,731	3.33
Total Army in United States including Alaska:									
Officers	124,266	1,148	9.24	2	.02	34	.27	42,701	.94
White enlisted	1,965,297	198,727	101.12	66	.03	4,879	2.48	3,619,990	5.05
Colored enlisted	145,826	84,867	581.94	36	.25	5,187	35.57	1,082,759	20.34
Total enlisted	2,111,123	283,594	134.33	102	.05	10,066	4.77	4,702,749	6.10
Total officers and men	2,235,389	284,742	127.37	104	.05	10,100	4.52	4,745,450	5.82
U. S. Army in Europe, excluding Russia:									
Officers	73,728	2,043	27.71	2	.03	6	.08	60,083	2.23
White enlisted	1,469,656	41,011	27.91	35	.02	161	.11	1,359,297	2.53
Colored enlisted	122,412	7,032	57.45	18	.15	68	.56	207,661	4.65
Color not stated		7,109		3		18		121,026	
Total enlisted	1,592,068	55,152	34.64	56	.04	247	.16	1,687,984	2.90
Total officers and men	1,665,796	57,195	34.33	58	.03	253	.15	1,748,067	2.88
Officers, other countries	8,388	109	12.99	1	.12	3	.36	3,173	1.04
U. S. Army in Philippine Islands:									
White enlisted	16,995	3,062	180.14	2	.12	6	.35	77,195	12.45
Colored enlisted	4,456	1,059	237.66	1	.22	1	.22	24,385	14.99
Total enlisted	21,451	4,121	192.12	3	.14	7	.33	101,580	12.98
U. S. Army in Hawaii:									
White enlisted	16,161	813	50.30			7	.43	25,156	4.26
Colored enlisted	3,319	193	58.15					4,690	3.87
Total enlisted	19,480	1,006	51.64			7	.36	29,846	4.20
U. S. Army in Panama: White enlisted	19,688	1,748	88.78	1	.05	6	.31	30,870	4.26
U. S. Army in other countries not stated:									
White enlisted		3,211		1		17		73,215	
Colored enlisted		1,448				5		916	
Color not stated		107				15		1,710	
Total	14,232	4,766	334.89	1	.07	37	2.60	75,841	14.60
Transports:									
White enlisted	97,498	2,025	20.77	1	.01	9	.09	23,157	.65
Colored enlisted	10,535	427	40.53	1	.09			3,013	.78
Color not stated		12						90	
Total	108,033	2,464	22.81	2	.02	9	.08	26,260	.67
Native troops:									
Philippine Scouts	18,576	680	36.61			3	.16	17,468	2.58
Hawaiian	5,615	314	55.92			5	.89	5,788	2.82
Porto Rico	11,831	824	69.64	3	.25	20	1.69	20,475	4.74

Venereal diseases, at least during their acute stages, are not among the common killing diseases. Therefore the number of deaths attributed to these causes in the Army during the World War is relatively small. The duration of the war and the length of service were too short for the most fatal type, syphilis, to show its effects. Table 41 shows that 173 deaths were attributed to venereal diseases in the total Army during the war. Among these, 5 were officers, 106 white enlisted men, and 56 colored enlisted men. Three cases were charged to native troops, and 3 to enlisted men whose color was not stated.

For a number of years prior to the World War, venereal diseases constituted a cause for the rejection of applicants for enlistment in the Army. Since this cause for rejection obviously could not obtain, in so far as the World War Army was concerned, from the first practically all cases of venereal diseases were deemed acceptable.[1] The number of cases discovered among the inducted men on their physical examination after their arrival at Army camps gives a very excellent measuring stick as to the incidence of these diseases among the young adult male population of the United States.

From the beginning of hostilities, in 1917, until May 1, 1918, about 1,000,000 men were inducted into the Army.[2] This is spoken of as the first million and is referred to in Table 42 as P_1. The physical examination blanks used at the time that these men were being inducted provided but one space for the notation of defects and only the major defects were noted; therefore, other defects, including venereal diseases, if not considered the major defect, were not listed. During the same period, organization was taking place with the draft boards and within the camps. Under these circumstances, it is to be supposed that the records do not show the occurrence of venereal disease as fully as was the case subsequently. The second million men, referred to as P_2 was called between May 1, 1918, and November 11, 1918. On the physical examination blanks used for the second million men, two spaces were provided for major defects. Local boards and camp examining boards were well organized and running smoothly. The records, therefore, are more complete. This second million was in reality 1,780,000 men, and, as notations shown on the original table[2] are based upon 1,000,000 men only, figures used in Table 42 are raised by multiplying those in the original table by 1.8, in order to estimate the total number of cases.

TABLE 42.—*Defects found in drafted men—Venereal disease (all)*[a] [b]

Venereal diseases	Group A			Group B			Group C			Group D and Vg					Total
	P_1	P_2	P_1 and $_2$	P_1	P_2	P_1 and $_2$	P_1	P_2	P_1 and $_2$	P_1	P_2	P_1 and $_2$	Cl. Vg	Total	
Syphilis	2,927	15,130	18,057	----	5	5	12	279	291	1,501	2,745	4,246	4,541	8,787	27,140
Chancroid	952	2,353	3,305	----	2	2	----	54	54	35	198	233	120	353	3,714
Gonorrhea	22,812	72,058	94,870	1	23	24	24	1,458	1,482	490	4,333	4,823	1,135	5,958	102,334
Total	26,691	89,541	116,232	1	30	31	36	1,791	1,827	2,026	7,276	9,302	5,796	15,098	133,188

[a] Source of information: Defects Found in Drafted Men. War Department, 1920, 424.

[b] A—Men selected for full military service. B—Accepted for remediable treatment. C—Accepted for special or limited service. D—Rejected at camps. Vg—Rejected by local boards. P_1—First million men. P_2—second million men and others.

Since venereal disease was not a disqualifying defect, very probably it was not carefully searched for; furthermore, the recorded cases, 133,188, were detected upon a quick routine physical examination without clinical history or full laboratory facilities.

With the less complete system of recording, 28,754 instances of venereal disease were reported among the first million drafted men. With the more complete system, as applied in the examination of the second million men,

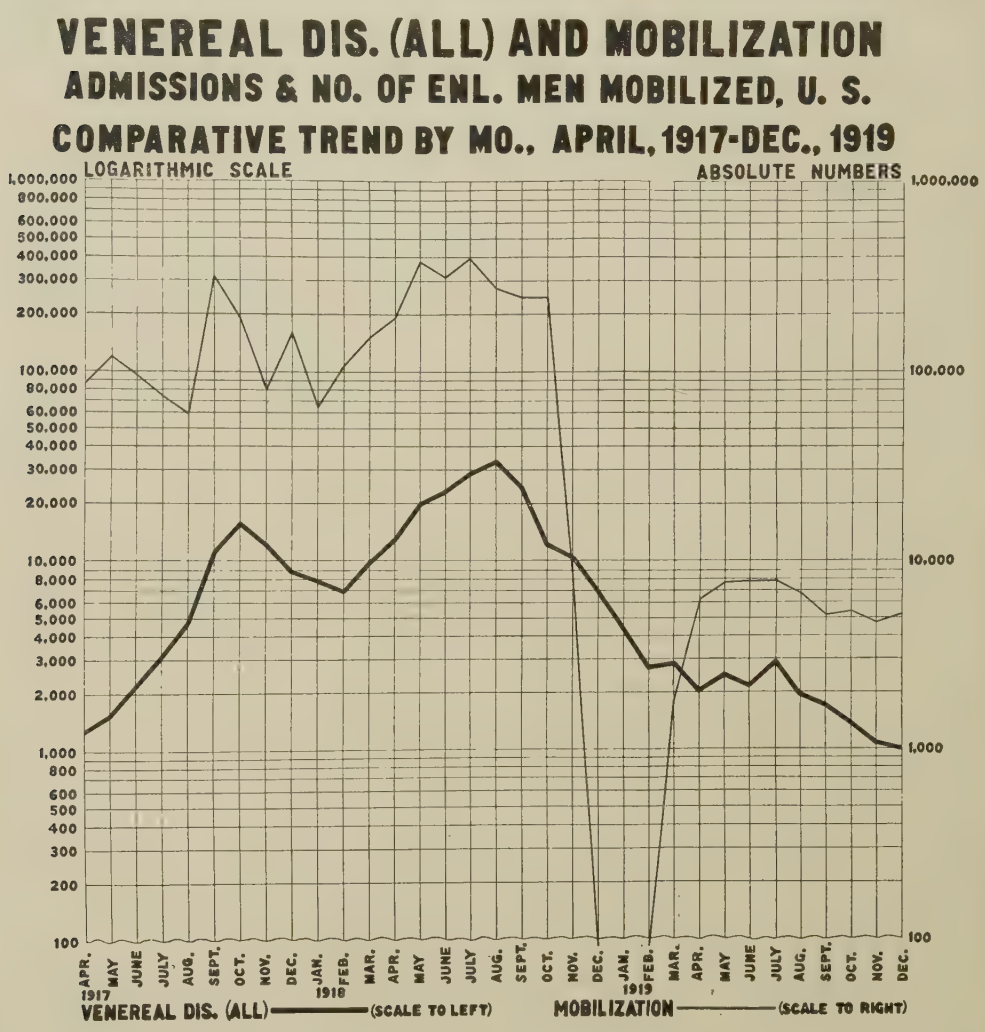

Chart XXXIII

54,843 cases of venereal disease were recorded by the camp examining boards alone. Taking the second million as an index of occurrence, the grand total of venereal diseases was shown to be 56.69 per 1,000, or 5.67 per cent. Among the 133,188 men with venereal disease reported in the second million, 15,098 were rejected. Venereal diseases accounted for nearly 5.8 per cent of all defects and were the third most important cause of defects found in camps.

If to the cases detected as outlined above we add cases which could be detected only by thorough physical examination, including the microscope for gonorrhea, and the dark-field and complement fixation for syphilis, the aggregate would be greatly increased. If incoming men brought venereal disease into the Army, a study by draft increments should show this. Chart XXXIII is designed to show the relation between the total venereal diseases by months (lower line) and the draft increments (upper line).

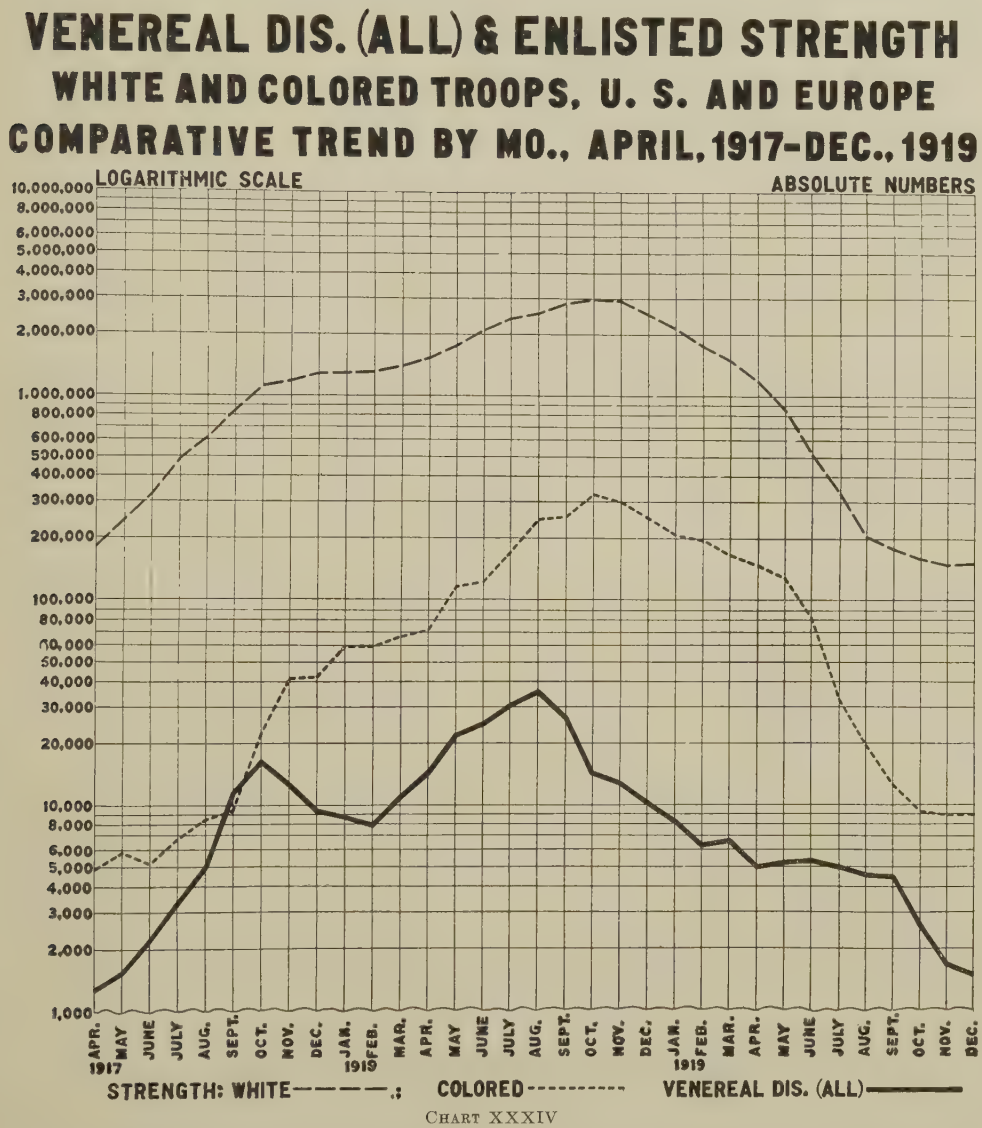

CHART XXXIV

Much has been said relative to the high incidence rate of venereal diseases among colored men. Where the number of inducted colored men was greater than the number of inducted white men, the incidence rate was also greater. Chart XXXIV shows the strength trend of white and colored enlisted men in comparison with the trend for venereal diseases. If this be consid-

ered in conjunction with Chart XXXIII, it becomes apparent that the proportion of venereal admissions increased as the proportion of colored strength to the white strength increased. To assist further in this visualization Chart XXXV has been prepared. This chart shows the actual monthly strengths for white troops, but the monthly strengths for colored troops were raised

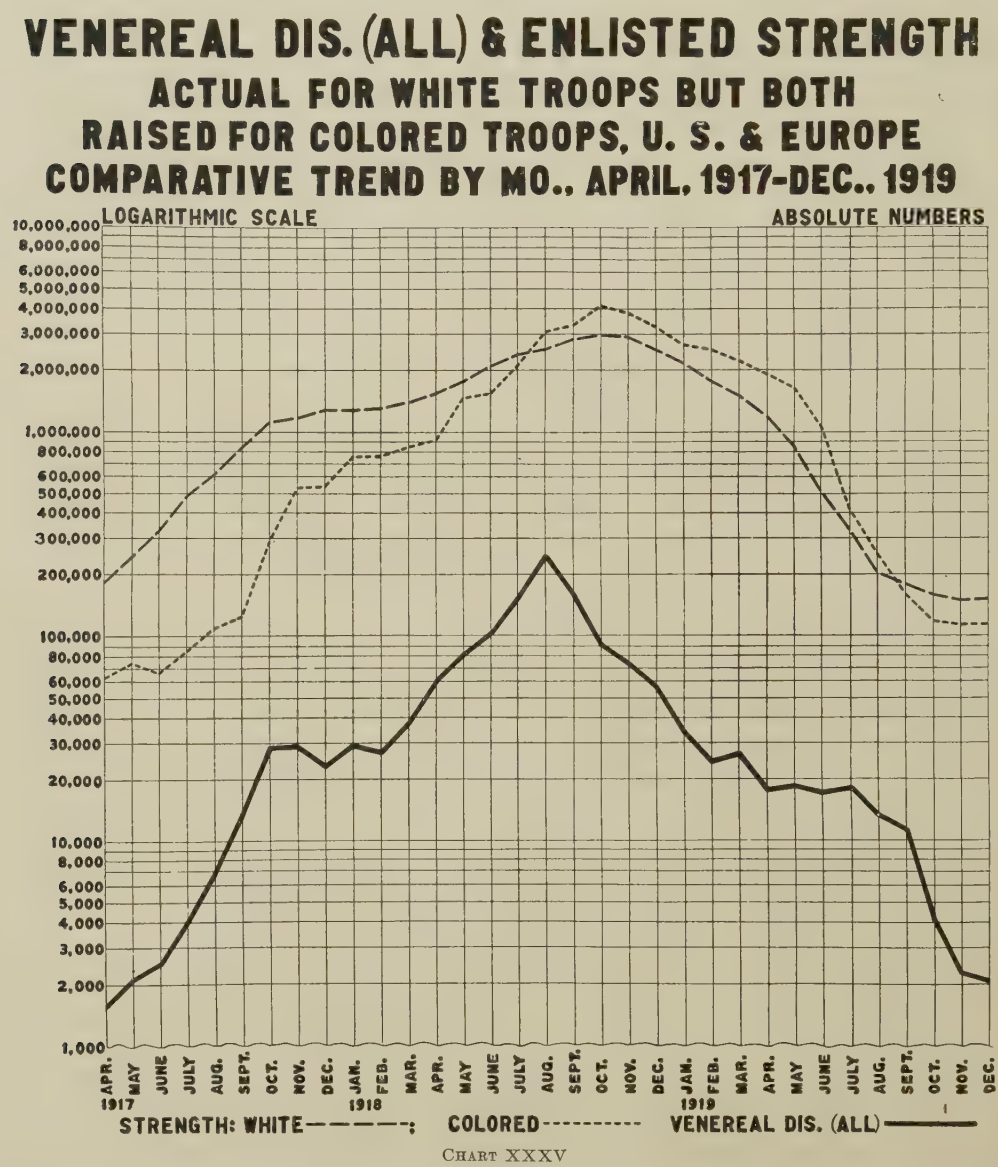

Chart XXXV

to what they would have been if the mean annual strength for the two races, for the war period, had been the same. The mean annual strength for the white troops for the war was to that of the colored troops as 12.805 is to 1. The actual monthly strengths for colored troops were, therefore, multiplied by the factor 12.805 to obtain the raised strength. In the same manner the

number of admissions for colored troops in the United States and Europe were multiplied by this factor to obtain the corrected number of cases for each month, which was then added to the true monthly admission figures for the whites. These figures were used as a basis for the heavy line.

Chart XXXV, considered in conjunction with Charts XXXIII and XXXIV should enable one to visualize the comparative effects of the white and colored population upon the absolute number of cases of venereal disease reported. It shows how closely the increase in venereal diseases followed the rise in the colored enlisted strength and how nearly the line of cases of venereal diseases paralleled the line for colored enlisted strength until the last peak of mobilization was passed in July. Chart XXXV also shows that colored enlisted men were inducted later and demobilized earlier than the white enlisted men; in other words, the average colored soldier was in the military service during a shorter period of time than was the white soldier.

OCCURRENCE IN THE ARMY IN THE UNITED STATES

Since the larger proportion of cases of venereal disease was imported into the service at the time of the draft, and since active steps were taken in the latter part of the summer of 1917 to prevent men with venereal disease from embarking for service abroad,[3] it is clear why the majority of cases should have been reported in the United States. Table 41 shows that of the total admissions for venereal diseases in the Army during the war, numbering 357,969, troops serving in the United States contributed 284,742, or 79.6 per cent. Whereas the admission rate per 1,000 per annum was 86.71 for the entire Army, the rate at home was 127.37. The admission rate was high for both white and colored enlisted men, being 101.12 and 581.94, respectively; but was low for officers (9.24). Although the admission rate for white enlisted men was less than one-fifth that for colored enlisted men, it was about one and one-half times the mean ratio of the total Army.

OCCURRENCE IN THE AMERICAN EXPEDITIONARY FORCES

In considering the incidence of venereal diseases in the American Expeditionary Forces, particularly when in comparison with the incidence in the Army in the United States, it is necessary to have in mind the fact that every effort was made both in the mobilization camps and at the ports of embarkation to detect all cases of venereal disease among men destined for overseas prior to their departure from the places mentioned.[3]

Table 41 shows for the Army in Europe, throughout the World War period, 57,195 primary admissions for venereal disease; the admission rate being 34.33 per 1,000 per annum as compared with 127.37 for the Army in the United States. Among enlisted men there were approximately five times as many admissions in the United States as in the American Expeditionary Forces, with an admission rate of approximately fifteen times greater at home. White enlisted men abroad contributed the bulk of the cases, approximately 41,000, and the admission rate was equal to that of the officers and one-half the rate of colored enlisted troops.

The noneffective rate for white enlisted in Europe (2.53) was approximately that of officers (2.23) and about one-half the rate at home (5.05). The non-

effective rate for colored enlisted men, American Expeditionary Forces (4.65), was about one-fourth that of colored enlisted men in the United States (20.34).

These differences are perhaps better shown by comparing the average number of days lost per case. Officers in the United States lost on an average of 36 days per case, against 33 days in the American Expeditionary Forces. The average for white enlisted at home was 18 days and abroad 33 days; while for colored enlisted at home the average was 12 days, against 29 days in the American Expeditionary Forces. The average for the Army at home was 16 days, against 31 days abroad.

For white troops serving in Europe—disregarding the abnormally high rates reported in the latter part of 1919 for the American Forces in Germany—the peak of admissions occurred in October, 1917. A marked drop occurred in June, 1918, with low rates subsequent to that time, due at least in part to the new system of reporting, by which only hospital cases were recorded on the sick and wounded reports. This same drop was apparent for colored enlisted men, the rate declining from 228.83 in April to 145.96 in May and to 88.54 in June. This lowered incidence rate was not entirely due to the system of recording, but was very materially influenced by the prophylactic system used in the American Expeditionary Forces.

OCCURRENCE IN OTHER COUNTRIES

The highest admission rate for enlisted American troops during the World War was not in the United States, as might have been presupposed, due to mobilization influences, but was in the Philippine Department, where very high venereal incidences have been recorded since the year 1898.[4] The Philippine rate for American troops during the war was 192.12 per 1,000 strength; the United States rate (134.33) held second place. Again, the incidence among colored enlisted men (237.66) was a material factor in causing this high rate; the incidence among white enlisted men in the Philippine Department was 180.14. The venereal disease rate among American troops in the Hawaiian Department was low (51.64) for both white (50.30) and colored (58.15) men. Native troops serving in their own country showed the lowest venereal incidence (50.46), with 1,818 cases among a mean strength of 36,022 men.

FACTORS INFLUENCING INFECTION

At the outbreak of the World War, the exciting causes of the venereal diseases were well known and accepted; therefore nothing is to be added herein along these lines. However, regarding the factors influencing infection, there has been much discussion, and the literature is rich in this material, the purpose of which was to remove these influences, as far as possible, in order that the venereal diseases might be held at lowest ebb. From the Army point of view, there were certain influencing factors which are worthy of special consideration. The most important of these are the incidence of venereal diseases among the civil population, the influence of age, race, length of service, prostitution, and alcoholism. With the exception of the influence on the Army rate of infection in recruits (to include newly drafted men), these factors are interwoven one with the other.

That the source of infection for the Army lies outside of the service requires no proof, as the opportunity for infection solely within the service is slight, in

fact so slight that it need scarcely be mentioned. It is true that very occasionally venereal infections have occurred and have been reported as being in line of duty, where, for example, an attendant became infected during the care of a patient; but the sum total of these cases is indeed small, and others arising within the service were of about the same rarity.

That race was an important element in the cause of venereal disease in the Army is shown by reviewing the records from any angle, as these diseases were far more prevalent among the colored troops. It is not intended to imply that colored men are more susceptible, or that the white soldiers possess a higher degree of immunity to venereal infection; but from the Army standpoint the greater the proportion of colored troops the higher the venereal rate.

Age, in like manner, is an important factor, as venereal disease is more common among the ages represented by the soldier age group seen during the World War. In this connection a study by length of service shows that the larger number of cases occurred among men with least service, and vice versa the smallest number of cases among those with longer service.

It is a matter of history that prostitution follows in the wake of armies. The soldier does not bring about this condition of lowered morality, but mobilization attracts women of both clandestine and professional types, and experience has shown that a very large percentage of such females are venereally infected.

Prostitution, in its relation to armies, was one of the most extensively studied of the health problems during the war. The calling of whole nations to service altered the conditions that obtained in former wars in which there were relatively small fighting forces, preyed upon by the professional prostitute. The World War greatly enlarged the field for venereal infection.

The dangers resulting from alcoholism were immediately appreciated when the United States entered the World War, and Congress empowered the President with authority to safeguard the troops against them.[5]

The following table shows admissions, absolute numbers, and ratios per 1,000 strength for alcoholism and venereal diseases (all) by years from 1917 to 1919, for total American troops in the World War:

Alcoholism and venereal disease (all). Primary admissions among total American troops during the World War. Absolute numbers and ratios per 1,000 per annum

Year	Alcoholism		Venereal disease	
	Cases	Rate	Cases	Rate
1917	1,835	2.73	82,299	122.62
1918	2,183	.87	226,875	89.72
1919	1,734	1.75	61,182	61.65

GONOCOCCUS INFECTION

Table 43 shows that the total incidence of primary admissions for gonococcus infection during the World War was 251,899. If to this figure cases reported as concurrent diseases (8,403) be added, the total occurrence for the American Army was 260,302, among a total mean annual strength of 4,128,479 officers and men. The strength from which the concurrent cases were reported can not be determined, therefore these cases are not included in further discussions on the occurrence of gonococcus infection unless specifically mentioned.

TABLE 43.—*Gonococcus infection. Primary admissions, deaths, discharges for disability, and noneffectiveness, officers and enlisted men, United States Army, by countries of occurrence, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000.*

	Admissions			Deaths		Discharges for disability		Non-effectiveness	
	Total mean annual strengths	Absolute numbers	Ratios per 1,000 strength	Asbolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Days lost	Non-effective ratio per 1,000 strength
Officers and enlisted men, including native troops	4,128,479	251,899	61.02	24	0.01	7,027	1.70	3,903,303	2.59
Total officers and men, American troops	4,092,457	250,874	61.30	24	.01	7,021	1.72	3,879,174	2.60
Total officers	206,382	2,027	9.82	2	.01	9	.04	60,922	.81
Total enlisted men, American troops:									
White [a]	3,599,527	178,322	49.54	20	.01	2,941	.82	3,179,595	2.42
Colored	286,548	66,466	231.95	2	.01	4,067	14.19	568,860	5.44
Color not stated		4,059				4		69,797	
Total	3,886,075	248,847	64.03	22	.01	7,012	1.80	3,818,252	2.69
Total native troops	36,022	1,025	28.45			6	.17	24,129	1.84
Total Army in United States, including Alaska:									
Officers	124,266	664	5.34			7	.06	20,907	.46
White enlisted	1,965,297	149,073	75.84	7	.00	2,863	1.46	2,353,700	3.28
Colored enlisted	145,826	61,901	424.49	1	.01	4,037	27.68	492,884	9.26
Total enlisted	2,111,123	210,974	99.93	8	.00	6,900	3.27	2,846,584	3.70
Total officers and men	2,235,389	211,638	94.67	8	.00	6,907	3.09	2,867,491	3.51
U. S. Army in Europe, excluding Russia:									
Officers	73,728	1,301	17.65	2	.03	2	.03	38,442	1.43
White enlisted	1,469,656	23,437	15.95	10	.01	62	.04	724,938	1.35
Colored enlisted	122,412	2,481	20.27			27	.22	59,130	1.32
Color not stated		3,980				4		68,982	
Total enlisted	1,592,068	29,898	18.78	10	.01	93	.06	853,050	1.47
Total officers and men	1,665,796	31,199	18.73	12	.01	95	.06	891,492	1.47
Officers other countries	8,388	62	7.39					1,573	.51
U. S. Army in Philippine Islands: [b]									
White enlisted	16,995	1,359	79.97	1	.06			37,035	5.97
Colored enlisted	4,456	457	102.56					12,139	7.46
Total enlisted	21,451	1,816	84.67	1	.05			49,174	6.28
U. S. Army in Hawaii:									
White enlisted	16,161	588	36.39			3	.19	17,461	2.96
Colored enlisted	3,319	124	37.36					2,278	1.88
Total enlisted	19,480	712	36.55			3	.15	19,739	2.78
U. S. Army in Panama: White enlisted	19,688	857	43.53			1	.05	12,835	1.78
U. S. Army in other countries and not stated:									
White enlisted [c]		1,547		1	.07	9		20,119	
Colored enlisted [c]		1,196				3		587	
Color not stated		72						773	
Total	14,232	2,815	197.80	1	.07	12	.84	21,479	4.14
Transports:									
White enlisted	97,498	1,461	14.98	1	.01	3	.03	13,507	.38
Colored enlisted	10,535	307	29.14	1	.09			1,842	.48
Color not stated		7						42	
Total	108,033	1,775	16.43	2	.02	3	.03	15,391	.39
Native troops:									
Philippine Scouts	18,576	378	20.35					10,206	1.51
Hawaiian	5,615	276	49.16			1	.18	4,614	2.25
Porto Rico	11,831	371	31.36			5	.42	9,309	2.16

[a] Includes total strength for "other countries and not stated."
[b] Includes troops in China.
[c] Separate strength for white and colored not available.

The ratio per 1,000 per annum for primary admissions was 61.02 for the total Army. Officers and enlisted men, American troops, contributed 250,874 cases (61.30), of which 2,027 (9.82) were officers. The remaining cases, 1,025, were among native troops (28.45). The rate of occurrence among enlisted men was 64.03 and about five times more common among colored troops (231.95) than among the whites (49.54).

Deaths, as would be expected, were very few, a total of 24 being reported 20 among white enlisted and 2 each among officers and colored enlisted men. There were 7,027 officers and men discharged from the service on certificates of disability on account of gonorrhea, with a discharge rate of 1.70 per 1,000 strength. These were cases with complications that unfitted the individual for the performance of his duties. There were nine officers (0.04), 2,941 white enlisted men (0.82), and 4,067 (14.19) colored enlisted men so separated from the service. It is to be noted that the discharge rate among the colored enlisted men was about fifteen times greater than among the white enlisted men.

The more important influence of gonorrhea on the fighting strength of the Army is shown in the number of days lost from duty, which was 3,903,303, a noneffective rate of 2.59 per 1,000. This disease ranked third among the 30 most common diseases in the Army, from a standpoint of noneffectiveness. Officers lost 60,922 days (0.81) and American enlisted men 3,818,252 (2.69) days. The noneffective rate among white troops (2.42) was approximately one-half (5.44) that of the negro troops. Gonorrhea among the native troops was consistently less in its various aspects than among American troops. The admission rate for the former was 28.45 and no deaths were reported.

OCCURRENCE BY MONTHS

Season, per se, as is well recognized, had no influence on the prevalence of gonococcus infection; however, a review of the incidence by years and months shows a marked variation. The annual rates, for example, for the three years of the war were, respectively, 93.66, 113.30, and 99.93 per 1000 strength for enlisted men in the United States as compared with the annual rate of 54.84 for 1916, the year preceding the entering of the United States into the war. Great variations are revealed in a study by months of occurrence. For white enlisted men in the United States during the first month of the war, April, 1917, the rate was 61.52, and rose to its peak for this year, in September, to 136.25, concomitant with the mobilization of a large number of drafted men. In January, 1918, the rate for white enlisted men had fallen to 48.29, with a report of 4,412 cases during that month. The mean enlisted strength was about 1,100,000 men. By July, which was the peak for 1918, the rate had increased to 133.81, and the mean strength to 1,300,000. There was a progressive decrease in the ratios until the summer and fall of 1919, when a gradual increase brought the trend to 72.32; the end of 1919 found the rate among white troops 56.27 per 1,000 per annum, with an average for the period of 75.84.

Fluctuations were much greater among the colored enlisted men, and the occurrence among them determined the monthly and annual ratios for gonococcus infections for the Army as a whole. The beginning of the war

found the admission rate for colored enlisted men at 49.26. This ratio rapidly increased to 408.04 in October, 1917, with the rapid increase in the number of colored drafted men, an increase from 4,870 in April to 21,795 in October. January, 1918, had a rate of 230.30 per 1,000 and a mean strength of 50,705. The rate increased rapidly throughout the spring and summer, reaching 988.38 in August. There was, relatively speaking, a gradual decrease during the following year and in August, 1919, it was 217.85. At the end of 1919 the admission rate for colored enlisted men decreased to 22.82, these troops being principally of the Regular Army type. The rate for colored enlisted men in the United States throughout the war was 424.49 as compared with 75.84 for the white enlisted men.

COMPLICATIONS, SEQUELÆ, AND CONCURRENT DISEASES

For the total Army there were among 251,899 primary admissions for gonococcus infection a total of 59,896 recorded complications, sequelæ, and concurrent diseases. Among the more important were arthritis, epididymitis, prostatitis, lymphadenitis, and associations with other types of venereal disease. Among the enlisted men, there were 14,777 cases of epididymitis, or 5.9 per cent of the total primary admissions were so complicated. Epididymitis constituted 24.7 per cent of the total complications and associated conditions. Arthritis was recorded as a complication in 7,895 cases, or 3.1 of the total primary admissions and 13.2 per cent of the total complications and concurrent conditions.

TABLE 44.—*Complications, sequelæ, and concurrent diseases, among primary admissions for gonococcus infections in the United States Army April 1, 1917, to December 31, 1919*

Disease	Cases	Per cent	Per cent of complications and concurrent diseases
Syphilis (all)	4,467	1.8	7.5
Chancroidal infection	4,272	1.7	7.1
Arthritis	7,895	3.1	13.2
Lymphadenitis	3,203	1.2	5.3
Prostate, diseases of	5,850	2.3	9.8
Epididymitis	14,777	5.9	24.7

Among concurrent conditions, syphilis and chancroidal infection were the most important. Of enlisted men admitted to sick report for gonorrhea, there were 4,467 cases in which syphilis was recorded as an additional diagnosis. That is, 1.8 per cent of the total primary admissions for gonococcus infection were associated with syphilis, and contributed 7.5 per cent of the complications and concurrent diseases. Chancroidal infections were reported in about the same proportions. There were 4,272 such cases, or 1.7 per cent of the total admissions to gonococcus infection. Chancroidal infections constituted 7.1 per cent of the total complications and concurrent diseases.

DIAGNOSIS

The diagnosis of gonorrhea in the Army during the war involved physical examination and microscopic examination of stained urethral smears and of cultures. While the majority of men having a purulent urethral discharge are

suffering from gonorrhea, one should not forget that organisms, other than gonococci, cause urethritis. The possibility of a nonspecific infection in the acute stage should always be borne in mind. It is important that the presumptive diagnosis made on physical examination alone be confirmed by microscopic means, since in the Army the line of duty status is dependent upon it. During the war there were 3,444 primary admissions for nonvenereal urethritis, or 0.83 per 1,000 strength. It was more common than hydrocele, acute or chronic nephritis, and about as common as cystitis. In proportion to gonorrheal urethritis, it occurred in the ratios of 1 nonspecific to 73 cases of gonorrheal urethritis.

In general, the practice was to look for urethral discharge during the regular semimonthly physical examinations and on special occasions. Cases showing discharge were sent to hospital for admission, further examination and treatment, unless for some particular reason such patients were admitted to a venereal ward or other place of treatment with the presumptive diagnosis of gonorrheal urethritis.

At the first examination, a note was to be made of the amount of discharge and of the condition of the glans and prepuce, the presence or absence of chancre and chancroid, and the testicles were to be examined for a beginning epididymitis. Then the two-glass test was to be given for the purpose of determining, first, if the posterior urethra was affected and, second, the amount of pus passed.

The following description is of the two-glass test and microscopic examination of the pus as extensively used during the war in permanent hospitals, segregation camps, and venereal clinics:[6]

The urine passed during gonorrhea appears turbid from admixture with pus, and in it are little clumps or masses of desquamated epithelium. After standing, the pus settles to the bottom of the glass and a cloud of mucus appears floating above it. As the patient goes on toward recovery, the pus disappears, but the hypersecretion of mucus continues and occasions a cloudiness of the urine, giving it a mucilaginous appearance. After the mucus disappears, the "clap-shreds" persist for months, because isolated portions of mucous membrane are not covered with epithelium and are still secreting pus.

In the two-glass test, if the anterior urethra alone is affected, the first glass of urine will be cloudy and the second glass clear; but if the posterior urethra is involved both glasses will be turbid from the presence of pus. This is accounted for by the action of the "cut-off" muscle which forms a barrier between the anterior and posterior urethra. It prevents pus in the anterior urethra from flowing back into the bladder; so that in anterior urethritis alone the pus in front of the cut-off muscle is washed out in the first flow of urine, while the last of the urine will flow over a clean surface and remain clear; that is, the first glass will be turbid, the second clear. On the other hand, in posterior urethritis, the cut-off muscle holds back the pus, as it does the urine in the bladder, and the pus flows back into the bladder and renders all the urine turbid. When the urine in posterior urethritis is passed into two glasses, the second glass is turbid as well as the first. If it is desired to determine the condition of the anterior urethra in posterior urethritis, it can readily be done by irrigating the anterior urethra with saline solution and collecting the washings in a glass for inspection.

Microscopic examination of pus.—Microscopic examinations of pus are indispensable, not merely for the establishment of the diagnosis, but also for the observation of the progress and stage of the disease, for the selection of the appropriate treatment for the different stages, and finally for the purpose of determining whether the gonococci have been eliminated and the patient cured.

The gonococcus.—The gonococcus is coffee bean or kidney shaped, and usually found in diplococcus form, the flat or slightly indented side of the organisms facing each other. In pus from acute gonorrhea organisms are found both within and without the cells, crowded in masses in the leukocytes. The intracellular location of the organisms is of diagnostic importance, but is not so characteristically seen in pus from chronic cases.

The gonococcus is easily stained with methylene blue or with most of the other anilin dyes. It is a Gram-negative organism, and for the purpose of differentiation from other diplococci a Gram stain is necessary. It is quickly decolorized by Gram's method and can then be counterstained with safranin or other stain. The Gram stain does not furnish an absolutely characteristic differentiation of the gonococcus from all similar cocci, but in pus from the urethra or vagina, or from the eye in cases of acute conjunctivitis, it may be accepted as a reliable test.

For the absolute differentiation of the gonococcus, cultural methods are necessary.

In the prodromal stage when the discharge from the meatus is thin and scanty, microscopic examination of smears shows quantities of desquamated cylindric epithelial cells and a moderate number of pus cells containing clumps of intracellular gonococci. In the ascending stage a large number of pus cells, many of them containing gonococci, and a number of free gonococci are to be seen. The stage of decline is indicated by the appearance of squamous epithelial cells, showing that the erosions have begun to cicatrize and have become covered with newly formed epithelium. Clumps of gonococci are also present, adhering to the epithelium. The pus cells have diminished in numbers and a smaller number of them contain gonococci. As the disease continues to improve, pus cells and gonococci disappear, and finally the discharge from the meatus is found to be composed only of squamous epithelium, mucus, and an occasional pus cell, without gonococci.

The diagnosis of gonorrheal arthritis was made upon the following symptoms and signs: The presence of, or a very recent history of, gonorrhea, pain and swelling (effusion) of a joint, commonly unilateral and a large joint of a lower extremity; fever; chronicity, and poor response to treatment. Paracentesis of the joint was used, but the extent can not be stated.

Gonorrheal ophthalmia had as its basis for diagnosis an acute purulent conjunctivitis in which the gonococcus was demonstrated; and in the few clinical records available for examination these patients also had acute gonorrheal urethritis.

Nothing new was developed during the war in the diagnosis of gonorrheal prostatitis, seminal vesiculitis, cowperitis, epididymitis, and other common complications of gonorrhea.

Complement fixation in the diagnosis of gonococcus infections was performed sparingly in the laboratories of the base hospitals, general hospitals, and other permanent or semipermanent institutions. It was not a routine procedure, but was considered of value when positive results were obtained. In like manner, cultural methods were reserved for special cases. While necessary for the absolute differentiation of the gonococcus, these methods are slow, time consuming, and were considered not necessary in the usual case of purulent urethritis, especially when a Gram-negative intracellular coccus had been demonstrated.

PROGNOSIS

The gonococcus is not a great destroyer of life. From the Army's point of view, prognosis is measured by deaths and discharges of men from the service, and by the days lost from duty for men temporarily incapacitated. Among 251,899 admissions for gonococcus infection there were but 24 deaths A more

detailed study of these deaths shows such concurrent diseases as pneumonia, and epidemic meningitis, which in all probability were the actual causes of death.

It was the policy not to discharge emergency men, who were venereal patients, from the Army in the United States during demobilization.[7] However, due to many urgent claims for release from military service after the armistice began, especially in 1919, and due to the chronicity of many cases, some of which had been under treatment for a long period, it became necessary to make exceptions to this rule. Table 43 shows 7,027 men discharged from the Army during the war for disability incident to gonococcus infection. This number constitutes 2.8 per cent of the total primary admissions for gonorrhea. They were discharged on account of complications and may or may not have been cured of the gonococcus infection. On the whole, the duration of American participation in the World War was too brief to reveal the outcome of cases of gonococcus infection.

Virulence of the gonococcus differs in different cases. It is at times noted that when a person has chronic gonorrhea, the gonococci, when transplanted into the tissues of another person, are not capable of producing such virulent inflammatory symptoms as when taken from a fresh case. This attenuated virulence explains the fact that in such cases the period of incubation is comparatively long, the purulent discharge is scanty, the cases often become chronic, and result in prostatitis and stricture.

Another factor which influences the prognosis of gonorrhea is the state of the patient's general health. Gonorrhea acquired by persons affected with phthisis, or who are debilitated from any cause, is apt to run a subacute, but exceedingly protracted, course. Other causes which retard recovery may be grouped as follows: Posterior urethritis, prostatitis, etc.; reinfection from an urethral gland, seminal vesicle, prostate, etc.; lack of rest; alcoholic indulgence; too vigorous treatment, especially injections which are too strong or too frequently repeated; coitus.

As stated above, the ultimate effects of gonococcus infection can not be measured by experience in the Army. Though more than 97 per cent of the cases were returned to duty, one can not state how many cases suffered from relapse or acute exacerbations among men discharged from the service as cured, or what eventually happened to men with venereal disease discharged for disability.

Analysis of the average days lost, for officers and enlisted men, and by countries, shows a great difference when compared one country with another. This may have been due, in part, to a difference in virulence of the organism or difference in resistance on the part of the patient; but it is believed the principal difference was in the system of management. The average number of days lost from duty per case was 15.4 for the total Army. It was 15.6 for American officers and men and 23.5 for native troops. The average among white enlisted was 17.8, and colored enlisted, 8.5. The average for total officers was 30 days. This difference is probably explained by the practice of holding an officer on sick report, once taken up for gonorrhea, until apparently cured, while an enlisted man was generally released from hospi-

tal or sick report as soon as the acute stage or symptoms had subsided and he was physically able to do duty. The soldier was restricted to the military garrison, assigned to a convalescent camp, development battalion, or venereal detachment with his organization. In either case his name was removed from the sick list.

As to the difference in race, there was a much larger percentage of colored drafted men with gonorrhea on entrance into the service than of white, and in both incidences the vast majority of cases had passed the very acute stage of the disease; furthermore, the colored soldier was often very anxious to be discharged from hospital especially when he was forfeiting his pay while confined there. These two factors are believed to account for the shorter period of hospitalization for gonorrhea among colored soldiers. In the United States the average for white and colored enlisted men was 15.8 and 7.9 days, respectively; in Europe the average for white enlisted men was 30.9, and colored, 23.8 days. The longer period in Europe, as compared with the United States, is accounted for, as above stated, by the fact that cases with complications were the ones usually admitted to sick report, while others were retained with their organizations.

TREATMENT [a]

ACUTE GONORRHEA

In order to aid the natural process of repair, the first essential is rest. No other measure contributes so much to a prompt and uncomplicated recovery as rest in bed during the acute stage of gonorrhea. The patient, therefore, should be put to bed and kept there during the ascending stage of from one to two weeks, or until the discharge becomes mucopurulent and the burning on urination has disappeared.

In order to keep the urine bland and unirritating and to promote frequent urination, so as to clear the urethra from the products of inflammation and to expel free organisms that may reinoculate new areas, the patient in bed should receive from the wardmaster and drink one glass of water every hour. The diet should be bland and of a low nitrogen content; highly seasoned and rich foods should be strictly excluded; cereals, fruit juices, toast and cream with a moderate amount of milk should make the bulk of the meals.

Alkalis and alkaline mineral waters should not be prescribed, because of their effect on the reaction of the urine. An acid reaction of the urine is the best safeguard against a cystitis from bacteria that find their way into the bladder. The acidity of the urine will be reduced sufficiently by the free use of milk and the abstinence from meat. The bowels should be kept open with aperients, and during the very acute stage a saline cathartic should be administered every other morning.

Dressings for the purpose of catching the urethral discharge to keep it from soiling the clothing always should be worn. Several varieties may be used: (*a*) For patients with a long foreskin, the familiar gauze butterfly; (*b*) for patients unable to hold the butterfly, a 4-inch gauze bandage bag with a

[a] Based upon "A Manual of Treatment of the Venereal Diseases, for the Use of Medical Officers of the Army". Prepared under the direction of the Surgeon General, 1917.

little gauze in the bottom, made fresh daily or oftener, or (*c*) a loose bag, made by cutting off the foot of a stocking, into the bottom of which gauze can be placed to catch the pus. The bags are to be suspended from a waist band. The loose bags permit and encourage a free flow of pus from the urethra, while they prevent retention. Constriction of the penis by dressings wrapped around it should carefully be avoided so as to insure no interference with the return circulation. A suspensory bandage should be worn when the patient is allowed to get up in order to relieve the sensation of dragging on the spermatic cord and to lessen perhaps the danger of epididymitis.

Oil of sandalwood is soothing and curative to the mucous membrane; it may be given during the acute stages, but will have little effect owing to dilution from the drinking of large quantities of water. Sandalwood oil should be administered in capsules in doses of from 0.5 to 1 c.c. three times a day after food. It sometimes disagrees with the digestion, or it may cause an intense pain in the back; when such symptoms occur, it should be discontinued. No copaiba or cubebs should be given in acute gonorrhea; they are serviceable only in the declining stages.

SEVERE ACUTE URETHRITIS

In very severe urethritis with intense reaction, profuse discharge, and great swelling and edema, it is good judgment to wait for some subsidence of the symptoms before beginning injections. In the meantime the parts should be kept clean; the penis held in hot water for 15 minutes at a time every few hours, and hot sitz baths given every three or four hours to relieve distress. If sitz baths are unobtainable, hot fomentations may be substituted. If pain on urination is very distressing, it may be relieved by an injection, five minutes before urination, of 1 c.c. of 1 per cent solution of cocain hydrochlorate or procain. Sandalwood oil diminishes the pain on urination in most cases, so that the use of a local anesthetic is not often necessary.

Local treatment.—In the ascending stage of acute urethritis and in other acute cases, which do not reach the intensity suggested in the preceding paragraphs, local treatment by injection may begin at once.

In selecting the drug used for injection, it is necessary to bear in mind the indications for its use, which may be thus formulated: 1. To destroy the gonococci in all foci within reach as early and completely as possible. 2. In doing so, to avoid irritation of the mucous membranes, any exacerbation of the existing inflammation, and everything that has a caustic action on the tissues and all unnecessary pain.

These indications are very well met by the silver protein compounds of the argyrol and protargol type. The syringe should be all glass, of 5 c.c. capacity, with a smooth acorn tip. For injection, solutions in water are used of the following strengths: Argyrol, from 3 to 5 per cent; protargol, from 0.25 to 1 per cent. Before injecting, the urine should be passed so as to wash out the pus accumulated in the urethral canal. In making injections the tip of the syringe should be firmly pressed into the meatus, and the penis should be held under moderate tension. The solution should be injected with the utmost gentleness. It should be held in the urethra for at least five minutes. If

injections produce distress, their strength should be reduced. Injections should not be given frequently enough nor sufficiently concentrated to cause any irritation of the mucous membrane; an injection which is too often repeated or is too concentrated prolongs the course of the case. In practice it is found that once in two hours is sufficiently often to destroy the gonococci without damaging the inflamed mucous membrane, provided the injection is carefully given and the solution is not too strong.

SUBACUTE ANTERIOR URETHRITIS

After from 10 days to 3 weeks in those cases that run a favorable course under the treatment with silver proteinates, the acute symptoms disappear. The discharge becomes watery and scant; microscopic examination reveals many newly formed desquamated epithelial cells and few or no gonococci; the urine in the first glass becomes clear or slightly turbid, although it contains many long mucous filaments. If treatment is now discontinued, relapse with extensive reinfection is certain to occur in from two to three weeks from the few gonococci left in the tissues. When the gonorrhea has reached this subacute stage, the task remains of curing the existing postgonorrheal lesions, which consist of a catarrhal inflammation of the mucous membrane, erosions, periglandular infiltrations, and infiltrations of the submucous tissues. Since the silver proteinates only destroy the gonococci and have little effect on the inflammatory processes, it is necessary at this time to treat the existing catarrh of the mucous membrane with astringent remedies. At this point in the progress of the disease it is highly desirable to substitute copious irrigations of the urethra for the hand injections.

Irrigations.—The solution best adapted for the double purpose of destroying the few remaining gonococci and of acting as an astringent to cure the superficial postgonorrheal lesions of the mucous membrane is silver nitrate in strengths of from 1:3,000 to 1:5,000 of distilled water. Irrigation with silver nitrate solution acts particularly well in the presence of a clear urine containing shreds of pus or mucous. It may be used every day or every other day. Potassium permanganate in water solution of the strengths of from 1:3,000 to 1:5,000 is also useful for irrigations. It is especially called for when there is a free purulent discharge containing no organisms. A purulent discharge that arises from the presence of a nongonococcic bacterial urethritis yields to irrigation with mercuric oxycyanide in solution in water in strengths of from 1:3,000 to 1:5,000. This should never be used if the patient is taking iodide or iodine in any form. The irrigations should be given at temperatures of from 110° to 115° F.—as hot as can comfortably be borne—and may be repeated as often as four times in 24 hours.

Technique.—The patient should sit well forward on the chair, resting his shoulders against its back, or he may stand. He should hold a small basin to catch the overflow of the irrigation. The irrigator tip is pressed against the meatus and the anterior urethra distended with fluid. Then by a short release of pressure of the tip a return flow is allowed. This is repeated until thorough irrigation of the anterior urethra has been obtained. If it is desired to irrigate the posterior urethra, the anterior urethra should first be washed out. Then

the tip should be firmly pressed against the meatus and the anterior urethra dilated with fluid. The patient is then instructed to take a long breath and to try to urinate; this releases the cut-off muscle and the irrigating fluid flows into the bladder. The bladder is allowed to fill with fluid, but should not be distended beyond the point of comfort. After the bladder is filled, the patient empties it by urination. Should difficulty be experienced in irrigating the posterior urethra from the meatus, a soft rubber catheter may be introduced through the cut-off muscle into the posterior urethra and the bladder filled through the catheter. The patient then urinates after the catheter is removed.

Under the irrigation treatment the urethral discharge ceases, and the shreds disappear from the urine, but before the patient is declared cured the condition of the prostate and vesicles must be investigated and the urethra must be found to be free from stricture.

It should be borne in mind that it is possible to treat a gonorrhea too long, and to cause the discharge to persist by the simple irritation of injections. In such cases, there will be a secretion free from gonococci which on squeezing will appear at the meatus as a small, transparent, glycerin-like drop, and which will cause sticking together of the meatus in the morning. In cases manifesting this condition, it is advisable to stop treament and to allow the irritation to subside. In consequence, the mucous discharge will often disappear spontaneously.

ACUTE POSTERIOR URETHRITIS

Severe posterior urethritis demands complete rest in bed and measures directed to the relief of the distressing symptoms. All local treatment of the urethra should be suspended. The nearer the diet approaches to a liquid or milk diet, the better. Abundant water should be taken, but diuretics should not be used, because they cause the too frequent evacuation of an already overtaxed bladder. Saline cathartics should be given every other day to reduce congestion in the pelvis. For the relief of tenesmus and pain, hot sitz baths of half an hour's duration, repeated several times a day, are useful. Alkalies, which favor the growth of bacteria in the bladder by rendering the urine alkaline, are contraindicated, as they are in acute urethritis. Sandalwood oil is not only curative, but soothing and gives relief in many cases. In the severe cases morphine should be given to relieve tenesmus and desire to urinate. It is best to give it in these cases in rectal suppositories.

As a rule, the acute stage of posterior urethritis disappears promptly, and the cases pass into the condition of mild posterior urethritis, and then should be treated as such.

SUBACUTE POSTERIOR URETHRITIS

In subacute posterior urethritis, treatment is given on principles similar to those applicable to subacute anterior urethritis. Solutions are applied to the surface, either by the injection of small quantities of concentrated solutions or by irrigations of copious quantities of dilute solutions.

In the first method, a small soft rubber catheter is introduced just beyond the cut-off muscle, and by means of a small urethral syringe about 10 drops of 1:500 to 1:100 solution of silver nitrate are introduced into the posterior

urethra. This is to be repeated at intervals of one or two days according to the tolerance of the case. In order to prevent immediate precipitation of the silver by the urine, the injection should be made with the bladder empty.

Urethrovesical irrigations by the gravity method are particularly applicable to the treatment of posterior urethritis. They are given through a gravity irrigator elevated 5 to 6 feet above the penis, according to the technique already described for irrigation. For posterior irrigations, protargol or similar silver protein preparation in the strength of from 1:1,000 to 1:250, or silver nitrate from 1:10,000 to 1:4,000, are used. Less effective, but still useful in some cases, is potassium permanganate, 1:3,000.

As a rule, posterior urethritis extends to the prostate and seminal vesicles, and persistence depends on reinfection from these structures. In every case these structures should be examined and, if necessary, treated.

COMPLICATIONS OF ACUTE GONORRHEA

FOLLICULITIS

The treatment of folliculitis consists in opening the abscess freely as soon as fluctuation is noticed, evacuating the pus, and allowing it to heal by granulation. It should be opened through a urethroscope from within the urethra, when this is practicable. If incision is done promptly, the occurrence of a persistent urethral fistula is prevented.

CHORDEE

The patient subject to chordee should empty his bladder just before going to bed; should sleep in a cool place, lightly covered; and, to avoid sleeping on his back, should tie a towel around his waist with a knot at the back. Before going to bed the penis should be given a prolonged immersion in hot water. When the patient wakes with chordee, he should get out of bed and immerse penis and testicles in cold or hot water, and before going back to bed should empty the bladder. He should be warned of the danger of "breaking" a chordee. In severe cases sedatives are necessary; potassium bromide, 2.0 gm., or camphor monobromate, 0.3 gm., in the afternoon and before going to bed, are useful; in extreme cases a morphine rectal suppository may be necessary.

EPIDIDYMITIS

Immediately on the development of epididymitis all injections or instrumentation of the urethra must be stopped, the patient be confined to bed, and put on a light diet. The testicles should be elevated by a bandage going under them and over the thighs, and hot applications should be made. Hot sitz baths for half an hour three times daily are soothing and hasten recovery. If the symptoms are severe, epididymotomy may be performed. This immediately relieves pain and hastens recovery.

In a few days the acute stage passes. The urethral discharge is then likely to recur, but local treatment of the urethra must be resumed only after a considerable period of rest and with the greatest caution. A suspensory bandage should be worn until the patient is entirely well. There is in many of these cases a chronic inflammatory exudate in the epididymis, which in time often disappears. Massage of it may hasten its absorption.

ACUTE PROSTATITIS

In acute prostatitis the indications are (1) to lessen the severity of the posterior urethritis; (2) to prevent suppuration of the prostate; (3) if pus forms, to evacuate it promptly by incision.

The patient should be put to bed, sandalwood oil administered, and, if necessary, the pain and tenesmus controlled by opium suppositories. Locally either ice bags or hot poultices are applied to the perineum, a safe guide for the choice between hot and cold applications being the amount of comfort which is given to the patient. Hot sitz baths of from one-half hour to an hour's duration two or three times daily are always indicated. Irrigation of the rectum with hot water for half an hour at a time may be used instead. A rectal prostatic irrigator, or, in its absence, a return flow catheter, is introduced into the rectum, and a continuous flow of water as hot as can be borne, is passed through it.

If retention of urine should occur, it may be necessary to introduce a catheter, but this should be done only when absolutely necessary. Before catheterizing, the urethra should be well irrigated to free it from pus. One c. c. of 2 per cent cocaine solution may be injected into the urethra to relieve pain and facilitate catheterization.

Prostatic abscess.—When a very limited area of suppuration of the prostate is present, involving perhaps two or three of the prostatic tubules, the temperature is only slightly elevated, and the local symptoms are not marked. After two or three days the temperature becomes normal and the tenesmus and frequent urination disappear. In such cases an incision into the prostate is not required, for the minute abscess generally ruptures into the urethra and the sinus fills in by granulation.

If, on the contrary, the symptoms do not improve within the first week, but the fever continues and chills occur, the local symptoms grow worse, and rectal examination shows an increase in the size of the inflamed prostate, it is evidence that an abscess is forming. These symptoms constitute an urgent indication to evacuate the pus; for if the pus is allowed to break through the capsule of the prostate, it will burrow through the tissues and may cause urinary infiltration and pyemia, or, at least, a fistula which will not heal without operation. In these cases immediate surgical measures are indicated. Two operations may be used to evacuate the pus: 1. The prostate may be exposed by a transverse incision in the perineum, and the collection of pus evacuated without opening the urethra. 2. An incision may be made in the perineal urethra, the mucous membrane of the prostatic urethra broken through with the finger, and the pus collection evacuated through the opening thus made.

ACUTE SEMINAL VESICULITIS

The general treatment of acute vesiculitis is the same as that for acute prostatitis, with which it is usually associated. Injections into the interior urethra, of course, are contraindicated; but above all things, any attempt at massaging or stripping the vesicles should be avoided.

CHRONIC GONORRHEA

CHRONIC ANTERIOR URETHRITIS

Based on the pathologic changes in the tissues, the indications for treatment are: (*a*) To rid the tissues of gonococci; (*b*) to cure the catarrhal inflammation in the mucous membrane and promote the formation of squamous epithelium to cover the erosions; (*c*) to cause absorption of the submucous infiltration; (*d*) to restore to normal the intraglandular and periglandular inflamed and infiltrated tissues. These indications can be met by irrigations with antiseptic and astringent solutions and by dilatations of the urethra with sounds and soft bougies.

When general catarrh of the mucous membrane is present and turbidity of glass 1 exists, free irrigation of the urethra and bladder by the gravity method, daily or every second day, using silver nitrate or potassium permanganate, soon clears up the diffuse inflammation in the mucous membrane, until the process is no longer general, but is reduced to isolated spots. This condition is denoted by glass 1 being no longer turbid; it does, however, still contain the shreds derived from isolated erosions which are not covered by epithelial cells and are still secreting pus, or from the prostatic ducts and Morgagni's crypts. Comma-shaped shreds which are often present are formed by the secretion from the open mouths of the prostate ducts and Morgagni's crypts. Gonorrheal shreds floating in clear urine continue until the submucous infiltrations resolve and the pathologic secretion of the prostate and crypts disappears.

In order to promote the absorption of the submucous infiltration it is necessary to pass steel sounds large enough to distend the urethra fully and put the ring of infiltration on the stretch. Meatotomy may be necessary in order to pass sounds of sufficient size.

The therapeutic effects of the sound can be materially increased by massaging the urethra over it with the fingers. The contents of Morgagni's crypts can in this way be expressed, and more favorable influence is exerted on the ring of infiltration in the submucous tissues.

Sounds may be passed too frequently. In cases of soft and recent infiltration, the intervals should be from four to seven days, always waiting until the reaction following has subsided. In cases of hard, organized infiltration the intervals should be a week. If the urethra is acutely inflamed and freely secreting pus, instrumentation is, of course, out of the question. Dilatations should not be started until the urine is clear and contains only shreds.

It makes no difference, as far as treatment is concerned, whether the submucous round cell infiltration is soft and recent or whether it has been transformed into scar tissue; the indications in either case are to promote its absorption by dilatation and pressure. Cases in which a considerable surface of mucous membrane is involved are unsuitable for dilatation until the catarrh has been checked by irrigations and the superficial process has been localized in a few spots in the urethra, as denoted by shreds floating in clear urine.

GLANDULAR URETHRITIS

Many intractable cases of gonorrhea lasting for years in spite of constant treatment are caused by a chronic inflammation of Morgagni's crypts. Such cases show few symptoms, the morning drop at the meatus being the most

constant. But they are characterized by exacerbations of the discharge after slight provocation, with a free discharge of pus containing gonococci, which leads the patient to believe that he has acquired a fresh infection. Urethroscopic examination shows the mouths of a few of the crypts to be open and pouting, with red and slightly elevated edges. In other cases the mouths of the crypts are occluded by a growth of epithelium. When the crypts are affected the gonococci may remain in them for years and the case remain infectious.

These cases should be treated by dilatations with full-sized sounds followed by irrigations. When the mouths of the glands are occluded by the growth of epithelium, dilatation of the urethra opens them and forces out the purulent secretion. The irrigating fluid enters the cavities and acts on the chronic inflammatory processes within the glands. In that form of inflammation in which the mouths of the glands are held open and the entire crypt is stiffened and inelastic from the periglandular infiltration, dilatations cause the absorption of the infiltrate around the glands and promote a return to normal condition.

When, after sufficient treatment by dilatations and irrigations, it is found by urethroscopic examination that a few glands still remain chronically inflamed and suppurating, and are thus foci of infection, these should be destroyed. This can be accomplished by bringing them into view with the urethroscope, and introducing a galvanocaustic needle. The cauterization must be very superficial and rapid; otherwise there will be danger of stricture formation. Not more than three or four crypts may be destroyed at a sitting. It is possible by destroying the glands harboring the gonococci to cure in this way a chronic gonorrhea of years' standing which has resisted all the other usual forms of treatment.

CHRONIC POSTERIOR URETHRITIS

In the presence of free pus formation urethrovesical irrigations by the gravity method with a solution of silver nitrate from 1:10,000 to 1:4,000 or potassium permanganate, 1:3,000, is the best method of rapidly reducing the purulent discharge. After the urethra becomes clear, the prostrate and vesicles should be examined, and if found to be diseased must be massaged in connection with the irrigation. When the urethroscope shows the infiltrated changes localized to the colliculus, direct applications of from 10 to 20 per cent silver nitrate solution should be made once a week through the endoscope. Granulations in the posterior urethra should be treated by cauterizing with strong silver nitrate solution. Small polypi, or granulations on the colliculus may be removed by scissors, forceps, or a galvanocaustic point. If the utricle is infected it should be injected with silver nitrate solution with a small syringe.

Chronic prostatitis.—In almost every case of chronic gonorrheal urethritis the prostate is involved. Chronic prostatitis usually originates in an attack of acute prostatitis, but it may result from a slow, insidious extension through the prostatic ducts of an infection from the posterior urethra. Aside from its frequency, chronic prostatitis is perhaps the most important complication of gonorrhea, for the reason that the gonococcus, with all its infectious qualities unimpaired, may be retained for years in the diseased tubular glands of the prostate without its presence being suspected. Probably most of the cases in

which wives are infected with gonorrhea by their husbands come from uncured prostatitis. Chronic prostatitis is also important on account of the profound disturbance of the nervous system and the impairment of the sexual function, which it occasionally produces.

The first indication in the treatment of chronic prostatitis is to improve the general condition of the patient by a proper regimen. Constipation is generally a prominent symptom, which is best treated with saline cathartics, because they have some effect in relieving pelvic congestion. All sorts of erotic excitement should be interdicted on account of their effect in inducing congestion of the prostate. Coitus should not be permitted, both because of its ill effect on the diseased prostate and because of the certainty of spreading the infection.

The most effective local measure is the emptying of the prostatic tubules of their retained and thickened contents by rectal massage two or three times weekly. In this procedure both lobes should be massaged from above downward and the manipulation should not be very vigorous, the object being to force out the prostatic contents by moderate pressure. Massage of the prostate is not well borne by all patients; and, if it produces irritating symptoms, it should not be persisted in. In order to lessen the danger of epididymitis from prostatic massage, it is advisable to irrigate the urethra and fill the bladder before massage with a solution of silver nitrate from 1:10,000 to 1:4,000 or potassium permanganate 1:3,000.

Treatment by massage and irrigation should be persisted in for from six to eight weeks, or until a microscopic examination of the expressed prostatic secretion shows only a small number of pus cells in the field. Many cases will be found to improve under massage up to a certain point and then remain stationary. In such instances it is advisable to stop treatment for a month. If after this intermission the remaining evidences of prostatitis have not disappeared, another course of massage may be given. Such treatment should be repeated until the pus cells in the expressed prostatic secretion are found on microscopic examination to be only from four to six in a field, and lecithin bodies are abundant.

While treating chronic prostatitis, it is important not to overlook the chronic posterior urethritis which nearly always accompanies it. This should be treated by irrigation, dilatation, and other measures, as already described.

Chronic seminal vesiculitis.—The treatment consists in massaging and expressing the contents of the vesicles twice a week. Massaging empties the vesicles of their inspissated contents, without forcing the muscular fibers to contract; and, by the relief of distention and the rest thus afforded them, the muscles recover their tone.

Contraindications to massaging are: (*a*) The existence of acute vesiculitis; (*b*) blood in the expressed material, or (*c*) excessive tenderness. With these conditions present, there is always danger of setting up an epididymitis.

In chronic vesiculitis the posterior urethra should not be overlooked, but should receive treatment, with irrigations or instillations or by applications made through the urethroscope as outlined under chronic posterior urethritis. It is desirable not to apply local treatment to the posterior urethra and massage the vesicles at the same sitting, but rather to allow a couple of days to intervene.

The duration of treatment must be protracted, for it requires from 2 to 12 months to effect a cure. In obstinate cases characterized by marked sexual neurasthenia or intractable gonorrheal rheumatism, free incision into and drainage of the seminal vesicles may be demanded. This is a procedure requiring expert skill.

CHANCROIDAL INFECTION

Chancroidal infection, more than gonorrhea or syphilis, is a disease of the careless and uncleanly, relatively uncommon among clean people, and readily prevented.[6] It was the least common of the venereal diseases in the Army during the war, contributing about 11 per cent.

Being an acute disease and without any known carrier state or common chronic complications, chancroid infection played a comparatively unimportant rôle among men entering the service; there were 3,714 cases among the first and second million drafted men examined. (See Table 42.) Of these, 120 were discharged as physically unfit for service by the local examining boards, and 233 by the camp examining boards.[8] Therefore, and in contradistinction to syphilis and gonorrhea, the great majority of cases were acquired by men while in the service. The ratio of chancroid to syphilis and gonococcus infection was 1 to 2 to 6.

There were 39,044 primary admissions for chancroid, with an admission rate of 9.46 per 1,000 per annum. Of these cases, 105 were discharged from the service on account of disability; loss of time from duty amounted to 973,614 days, with a noneffective rate of 0.65 per 1,000 strength. As might be presumed, chancroid was relatively uncommon among officers, more common among white enlisted men, and with greatest frequency among native and colored enlisted men. There were 374 primary admissions for officers (1.81), 26,819 among white enlisted (7.45), 271 for native (7.52) and 9,937 among colored enlisted men, with the very high rate of 34.68 per 1,000 strength. More than 60 per cent of the discharges following chancroidal infection in the total Army were among colored enlisted men.

Although not as disabling to the fighting strength of the Army as either syphilis or gonorrhea, chancroidal infection caused considerable noneffectiveness. The ratio per 1,000 strength was 0.65 and the average number of days lost from duty per case was 24.9 as compared with 28.7 for syphilis and 15.4 for gonorrhea. The difference in time lost per case was approximately the same between officers (24.5), white (25.7) and colored (25.3) enlisted men. The average number of days lost among native troops was 23.4. Although the average number of days lost among the enlisted men, white and colored, was about the same, the noneffective rate was about five times greater for colored enlisted men.

DIAGNOSIS

The practical diagnosis of chancroidal infection is based upon the period of incubation and the clinical appearance of the ulcer. Autoinoculation, and cultural and microscopic examinations for the Ducrey bacillus, have been used but without encouraging results for routine practice. These methods were known before the war and nothing new and of special value developed during that time. In view of the vital importance of differential diagnosis between

chancroid and syphilis, and the great importance of diagnosing syphilis as coexisting with chancroid, much stress during the war was placed on the early and thorough examination of all venereal ulcers to determine whether or not syphilis was present.[7]

Where sores were concealed it was recommended that the necessary incision, either dorsal or bilateral be made, in order that the lesion might be exposed for diagnostic and therapeutic purposes. Moore[9] made a special report on the diagnosis of chancroid, and the effect of prophylaxis upon its incidence in the American Expeditionary Forces. During the 12 months ending March, 1919, there was afforded opportunity to see over 4,000 venereal cases, among which more than 800 were venereal ulcers. In a selected 10-month period, ending in February, 693 venereal ulcers were encountered. The original diagnosis, based on the clinical appearance of the sore and dark-field examination, was chancroid in 379 instances, or 54.5 per cent, and primary syphilis in 314, or 45.5 per cent. In order to obviate the possibility of unrecognized syphilis, an effort was made to follow each chancroid case for at least eight weeks, but, owing to military exigencies, this was possible in only 135 cases. Every sore was suspected as being syphilis until proven otherwise, and it was an unalterable rule that dark-field examination should be carried out on every sore for three consecutive days before search for the spirochete was abandoned. Moore declared that while it had been conclusively demonstrated that the bacillus of Ducrey is the cause of chancroid, it is exceedingly hard to find. In 81 cases, clinically chancroid, in which smears were made, the Ducrey bacillus was demonstrated 20 times; while in 61 cases the smears were negative. Cultures on serum blood agar were made 55 times and were positive in only 5 instances, proving that these methods of microscopic and cultural diagnosis are not to be relied upon. A Wassermann test was made when the patient was first seen, once a week thereafter for the first 8 weeks, and at the middle and end of the third month. All of the 135 cases were followed for more than 8 weeks, 97 of them for more than 12 weeks.

Autoinoculation proved to be of very little value for two reasons, according to Moore:[9] First, because of the difficulty of controlling ambulatory patients, who frequently developed large spreading ulcers at the site of inoculation, which were very difficult to heal, and, second, because so-called positive reactions (positive in 24 to 48 hours) can be obtained from secondarily infected ulcers in which the spirochete can be demonstrated. A few experiments were conducted by Moore in Paris. Five men were selected with clinically typical chancroid, and from the sores three inoculations, about 2 inches apart, were made on the left arm. The top inoculation was left as a control; the middle one was treated at various intervals after inoculation, ranging from 10 minutes to 2 hours, with calomel ointment well rubbed in for exactly five minutes. The bottom inoculation was treated with tincture of green soap and warm water at the same intervals and with thorough use for five minutes. In all cases, the controls were positive, as was the inoculation treated with calomel ointment, while the lesion treated with soap and water was uniformly negative. Therefore, it may be stated that the history of incubation, clinical appearance of the sore, and examinations to determine the presence of the Ducrey bacillus

are no more than suggestive in ruling out primary syphilis. All venereal ulcers should be repeatedly examined by dark-field illumination before local application of antiseptics or the cautery; all patients with chancroid infections should be subjected to frequently repeated Wassermann tests for several months, to prove the presence or absence of syphilis.

COMPLICATIONS, SEQUELÆ, AND CONCURRENT DISEASES

There were 39,044 primary admissions for chancroidal infection and 7,679 cases reported as concurrent with other diseases. making a total of 46,723 cases for the total Army during the war. The most common and more important concurrent diseases were syphilis and gonorrhea. Chancroid was associated with syphilis in 3,687 cases, or 8.8 per cent. Gonorrhea was more commonly so associated; there were 5,221 cases in which gonorrhea and chancroid coexisted, or 11.11 per cent.

PROGNOSIS

The prognosis of chancroidal infection in the Army, as to recovery, was good. Among 39,044 cases of chancroid, 105 were discharged from the service on account of permanent disability, though it is very probable that causes other than chancroid were contributory in many of these. Among the primary admissions there were 4,811 complications and concurrent diseases, with one death; therefore it can be said that chancroidal infection did not increase the liability to death. Recovery was complete in all cases, with the possible exception of scars at the site of infection or operation. As to duration of the illness, but few diseases showed such a consistent general average among officers and enlisted men.

TREATMENT [a]

GENERAL TREATMENT

In order to hasten recovery, the patient with chancroid should be put to bed, kept clean, and given a nourishing diet. Rest not only makes for a prompt healing of the chancroid, but greatly reduces the danger of bubo. Destructive chancroids are seen in the dirty and debilitated. If patients with chancroids are kept clean and well nourished, healing is usually prompt, and extensive ulceration very rarely seen.

LOCAL TREATMENT

Abortive treatment.—In a certain proportion of cases of chancroid, abortive treatment is successful. The principle of all methods of abortive treatment is to convert the infected ulcer into a sterile one by the use of some destructive agent. This may be either the actual cautery, or one of several strong chemical caustics.

The thermocautery is doubtless the best agent for this treatment Its application is as follows: The ulcer is thoroughly cleaned and well dried; then the entire area of it is seared with a cherry red cautery. Every particle of diseased tissue must be destroyed. It should be done under a general anesthetic, preferably gas.

[a] Based upon A Manual of Treatment of the Venereal Diseases, for the Use of Medical Officers of the Army. Prepared under the direction of the Surgeon General, 1917.

Chemical cauterization is done as follows: The ulcer is well cleaned, being first irrigated and then dried. Then a pledget of cotton wet with 5 to 10 per cent solution of cocain hydrochlorate or procain is applied to it. After anesthesia is produced the ulcer is dried as thoroughly as possible, preferably with blotting paper, in order to prevent the running of the chemicals subsequently to be applied. After it has been thoroughly dried, the entire surface of the ulcer, both edges and base, is touched with pure liquid phenol (carbolic acid) applied on a small cotton swab, care being taken to let no infected point escape. Then the excess of phenol on the surface is taken up, and nitric acid is applied lightly in the same way. The ulcer should be flushed immediately with sterile water to stop the action of the acid. Instead of nitric acid a saturated solution of zinc chloride can be used. This is as active a caustic as nitric acid, and its action should be stopped as quickly after application by flushing with water.

After cauterization in any of these ways the wound should be dressed with cold compresses of boric-acid solution or similar bland solution. There results an acute inflammatory reaction, the slough is thrown off, and in successful cases a healthy granulating surface is left.

The advantage of these methods of treatment is that, in successful cases, healing takes place quickly and the danger of bubo is almost eliminated. Their success depends on thoroughness in destroying the infected area. If the procedure fails to do this completely, harm results, because it produces a larger ulcer, which becomes infected from the focus of disease that has been left. Attempts at abortive treatment with superficial caustics, such as silver nitrate, are always failures. Attempts at abortive treatment should not be made unless the prospects of complete destruction of the diseased tissue are good.

Abortive treatment is contraindicated under the following conditions: (1) When the diseased area or areas are so extensive or so situated that the destruction produced by this treatment would result in considerable deformity. The chief situation in which it is contraindicated is in chancroid at the meatus. (2) When the inflammatory reaction is already intense and there is much edema. These would be increased by cauterization. (3) When there is inguinal adenitis. This would be aggravated by cauterization. (4) In healing chancroids. Here the infection is already under control and nothing would be gained by cauterization.

Abortive treatment will, of course, interfere with any further search for spirochetes. For this reason it should never be undertaken until every reasonable effort to find the spirochetes has been made. The early diagnosis of syphilis is so much more important than the prompt healing of a chancroid that efforts to heal the chancroid should be given no consideration until the question of diagnosis is settled as far as possible. And after successful abortive treatment there should be no relaxation in the weekly Wassermann tests or in the clinical observations until syphilis can be finally ruled out.

In all cases, except those favorable for abortive treatment, reliance is placed on cleanliness, the use of antiseptics, and measures to promote healing. The first principle in treating chancroids is to keep them as free as possible from pus, both to promote healing of the ulcer and to prevent infection of the

lymphatics. In all cases, for the effect of the heat as much as for cleaning effect, the patient should hold the penis in hot water for half an hour several times daily. Then the lesion should be given a copious warm irrigation with boric acid solution or mercuric chloride, 1:10,000, or potassium permanganate, 1:3,000, or some other nonirritating antiseptic solution. Then the ulcer should be dusted with an antiseptic, such as iodoform (the preferable antiseptic), thymol iodide, calomel, or argyrol. After this there should be applied a moist dressing of one of the solutions which are used for irrigating the ulcer. In very acute cases a good dressing is one wet with aluminum acetate solution, 1 part of the 8 per cent solution of aluminum acetate to 7 or 15 of water. The dressings must be kept continually moist and changed frequently enough to prevent accumulation of pus on the ulcer.

When for any reason it is impracticable to keep a wet dressing constantly applied, the next best course to pursue is to dust the ulcer after irrigation with argyrol crystals or iodoform and then cover it with gauzes spread with petrolatum. Dry powders alone are not good applications for chancroids. They cake into crusts, under which the pus accumulates, and this materially increases the risks of infection of the lymphatics and the occurrence of bubo.

Occasionally in the course of healing of chancroids, the granulations become sluggish; in such cases, stimulation by the application of balsam of Peru works well, or the granulations may be touched occasionally with silver nitrate. If there is an overgrowth of the unhealthy granulations, they should be trimmed off with a knife or razor or seared with a cautery, and then dressed with iodoform and a wet compress.

In chancroids under a greatly swollen or long, tight prepuce, wet dressings can not be used. In these cases prolonged soakings in hot water several times daily are particularly serviceable. After each soaking the preputial sac should be cleaned by inserting into it a catheter or a long flat syringe nozzle and thoroughly irrigating with hot antiseptic solution. After the irrigation there should be injected into the preputial sac from 2 to 4 c. c. of a suspension of antiseptic powder in oil or glycerine, such as 20 per cent calomel, 10 per cent thymol iodide, or 10 per cent iodoform in oil or glycerine. Of these, 10 per cent iodoform in glycerine is best.

In patients with a long prepuce it is best not to make a dorsal slit, if progress can be made without so doing for if a dorsal slit is made, the whole surface at once becomes chancroidal. Not infrequently in cases with intense reaction and great swelling no headway can be made while the prepuce is intact; in other cases the reaction becomes so exaggerated that, unless relief of tension is given, sloughing of the prepuce will occur. Under these conditions a linear slit along the dorsum of the prepuce should be made, and the case then treated as an open chancroid. A complete circumcision should never be attempted until the infection has entirely disappeared.

SUPPURATIVE INGUINAL ADENITIS

Under the usual conditions of treatment of chancroids, when patients are not in bed, suppurative inguinal adenitis occurs in from 30 to 50 per cent of the cases. But the factors that predispose to bubo are muscular activity and

accumulation of pus on the chancroid; so that with patients in bed and with their chancroids kept free from pus, bubo is a relatively infrequent complication.

When bubo threatens, extra care should be used to see that there is no absorption of pus from the chancroid; the patient should have complete rest, and hot applications should be applied. If fluctuation develops, the hot applications are continued until the gland has fully broken down. When it is soft throughout and full of pus, a small incision with a double-edge knife should be made and the pus evacuated. Iodoform glycerin, 10 per cent, is then injected into the cavity. The emulsion should be injected three times at the first sitting. The first two injections run out and the last one remains in. The wound is then bandaged with gauze, moistened with solution of aluminum acetate, 1 part in 7 of water, or boric-acid solution, or some other antiseptic solution. On the following day the wound is emptied by squeezing, and iodoform emulsion injected once and left in. The bandage is then applied, and in five or six days the wound is closed and healed. If after a week the wound is not closed, it should be injected again; this will usually result in healing in five or six days.

The method of injecting the wound with silver-nitrate solution has been abandoned on account of the pain that it causes and because it is no better than the injection with iodoform.

The plan of encouraging suppuration and evacuating the pus through a small incision is satisfactory in most cases when the glands break down rapidly. But sometimes suppuration goes on very slowly; and in these cases it is better to make a free incision, evacuate the pus, and dissect or curette out the partially broken-down remains of the glands. Then the wound is packed with gauze and allowed to heal by granulation. It is better to avoid this course if possible, as the subsequent healing takes six or eight weeks and requires daily dressing.

It was the practice a few years prior to the World War to endeavor to prevent suppuration in the glands by dissecting them out and trying to get a clean wound, which was closed by suture. This practice has now been abandoned because it was found that a solid edema, or elephantiasis, of the penis and scrotum and inguinal region often followed, in consequence of the obliteration of the lymphatic vessels in the area of the wound. Another objection was that, when patients came to operation, suppuration had nearly always begun in the center of the gland, even though no fluctuation was evident; the wound was not aseptic and could not be closed, but had to be left open for the slow process of healing by granulation.

SYPHILIS

Table 45 shows the occurrence of syphilis in the Army during the World War by countries of occurrence for officers and enlisted men. In addition to the 67,026 primary admissions, all forms, 9,665 cases were reported as concurrent with other diseases, making a total of 76,691; that is, with a total mean strength of 4,128,479 men, 1.85 per cent were admitted to sick report on account of syphilis.

TABLE 45.—*Syphilis. Primary admissions, deaths, discharges for disability, and noneffectiveness, officers and enlisted men, United States Army, by countries of occurrence, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

	Total of mean annual strengths	Admissions		Deaths		Discharges for disability		Noneffectiveness	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Days lost	Noneffective ratio per 1,000 strength
Officers and enlisted men, including native troops	4,128,479	67,026	16.24	143	0.03	3,318	0.80	1,927,901	1.28
Total officers and men, American troops	4,092,457	66,504	16.25	140	.03	3,297	.81	1,914,653	1.28
Total officers	206,382	899	4.36	3	.01	33	.16	35,835	.48
Total enlisted men, American troops:									
White	3,599,527	45,456	12.63	82	.02	2,104	.58	1,338,950	1.02
Colored	286,548	18,623	64.99	53	.18	1,131	3.95	502,437	4.80
Color not stated		1,526		2		29		37,431	
Total	3,886,075	65,605	16.88	137	.04	3,264	.84	1,878,818	1.32
Total native troops	36,022	522	14.49	3	.08	21	.58	13,248	1.01
Total Army in United States, including Alaska:									
Officers	124,266	413	3.32	2	.02	27	.22	19,445	.43
White enlisted	1,965,297	34,915	17.76	56	.03	1,984	1.01	919,290	1.28
Colored enlisted	145,826	16,200	111.09	35	.24	1,089	7.47	407,226	7.65
Total enlisted	2,111,123	51,115	24.21	91	.04	3,073	1.46	1,326,516	1.72
Total officers and men	2,235,389	51,528	23.05	93	.04	3,100	1.39	1,345,961	1.65
U. S. Army in Europe, excluding Russia:									
Officers	73,728	454	6.16			4	.05	15,293	.57
White enlisted	1,469,656	8,672	5.90	24	.02	96	.07	368,875	.68
Colored enlisted	122,412	2,039	16.66	17	.14	41	.33	90,646	2.03
Color not stated		1,515		2		14		36,843	
Total enlisted	1,592,068	12,226	7.68	43	.03	151	.09	496,364	.85
Total officers and men	1,665,796	12,680	7.61	43	.03	155	.09	511,657	.84
Officers, other countries	8,388	32	3.81	1	.12	2	.24	1,097	.36
U. S. Army in Philippine Islands:									
White enlisted	16,995	609	35.84	1	.06	5	.29	15,098	2.43
Colored enlisted	4,456	143	32.09	1	.22			1,842	1.13
Total enlisted	21,451	752	35.06	2	.09	5	.23	16,940	2.16
U. S. Army in Hawaii:									
White enlisted	16,161	122	7.55			4	.25	4,210	.71
Colored enlisted	3,319	47	14.16					1,842	1.52
Total enlisted	19,480	169	8.68			4	.21	6,052	.85
U. S. Army in Panama: White enlisted	19,688	277	14.07	1	.05	2	.10	7,446	1.04
U. S. Army in other countries and not stated:									
White enlisted		610				8		18,040	
Colored enlisted		141				1		184	
Color not stated		9				15		540	
Total	14,232	760	53.40			24	1.69	18,764	3.61
Transports:									
White enlisted	97,498	251	2.57			5	.05	5,991	.17
Colored enlisted	10,535	53	5.03					697	.18
Color not stated		2						48	
Total	108,033	306	2.83			5	.05	6,736	.17
Native troops:									
Philippine Scouts	18,576	195	10.50			2	.11	4,278	.63
Hawaiian	5,615	23	4.10			4	.71	989	.48
Porto Rico	11,831	304	25.69	3	.25	15	1.27	7,981	1.85

The primary admission rate per 1,000 strength was 16.24 for the total Army and the total days lost from duty was 1,927,901. One hundred and forty-three deaths were charged to syphilis. Since the duration of the war was short, the above number of deaths obviously does not represent the toll that was claimed by syphilis among soldiers.

The above figures are not intended to represent total syphilis in the Army, but only those cases with manifest lesions. Doubtless there were many cases that were never recognized. Levin[10] made more than 10,000 blood tests on troops at Camp Funston, Kans., and at Fort Riley. These tests were made on men from all walks of life. He found the percentage of syphilis among officers to be low, with one double-plus reaction in 59 cases examined. The following table shows the results of this survey, among white and colored enlisted men:

Comparison of figures obtained in surveys of white and colored men

Troops	Number examined	Known syphilitics	Wassermann	Undoubted syphilitics	Wassermann	Estimated probable syphilitics
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
White	1,577	3.44	4.77	8.21	7.87	16.08
Colored	1,422	1.08	21.80	22.88	13.11	36.00

For the total Army during the war there were 67,026 primary admissions for syphilis, of which 899 were officers. White enlisted men furnished 45,456, and colored enlisted 18,623 cases. The admission rate for officers was 4.36; for white enlisted men, 12.63; and for colored enlisted men, 64.99 per 1,000 strength. Of the deaths recorded, 3 were among officers and 137 among enlisted men. White enlisted men contributed 82 and colored enlisted men 53 of these deaths, with ratios of 0.02 and 0.18, respectively. This same higher incidence among the colored enlisted men is also shown by discharges for disability and days lost from duty. The discharge rate for the white was 0.58 and for the colored enlisted men 3.95. White enlisted men lost 1,338, 950 days from duty and colored enlisted men 502,437. The noneffective rates were, respectively, 1.02 and 4.80. The disease was relatively less common among native than among American troops. For the former there were 522 cases (14.49), with 3 deaths (0.08), 21 discharges for disability (0.58), and a loss of 13,248 days (1.01) from duty.

OCCURRENCE IN THE ARMY IN THE UNITED STATES

The vast majority of syphilis cases in the Army were reported in the United States. There were 51,528 primary admissions, with the high rate of 23.05 per 1,000 per annum. This disease was more common among white enlisted men in the United States (17.76) than in the Army at large (12.63); however, only about one-seventh as common as among the colored enlisted men. Among the latter there were 16,200 primary admissions, with the high rate of 111.09 per 1,000 strength. The majority of deaths, and practically all the discharges for disability, were recorded for troops serving in the United States. The death rate among white enlisted men was one-eighth (0.03) that of colored enlisted men (0.24), and the discharge rate was almost in the same proportion.

Time lost from duty amounted to approximately 900,000 days for white enlisted and 400,000 days for colored enlisted, with noneffective ratios of 1.28 and 7.65 per 1,000, respectively. The average enlisted rate at home was 1.72.

OCCURRENCE IN THE AMERICAN EXPEDITIONARY FORCES

As shown in Table 45, syphilis was not as commonly reported in the American Expeditionary Forces as in the Army in the United States. There were 12,680 primary admissions in the former against 51,528 in the latter. The admission rate in the American Expeditionary Forces was 7.61 per 1,000 and 23.05 in the Army in the United States. Syphilis was about twice as common among officers abroad as it was at home, the admission ratios being 6.16 and 3.32 per 1,000 strength, respectively. It was about one-third as common among enlisted men overseas (7.68) as in the United States (24.21); and at home it was more common among colored (111.09) than among the white enlisted men (17.76). Among colored enlisted men abroad there were 2,039 primary admissions, and among white enlisted men 8,672, with admission ratios of 16.66 and 5.90 per 1,000 per annum, respectively.

OCCURRENCE IN OTHER COUNTRIES

Syphilis has been a common disease among American troops in the Philippines since the first occupation of these islands in 1898. During the World War there were 752 primary admissions among the enlisted man, white and colored, with admission ratios of 35.84 and 32.09, respectively; in this instance the rate was higher among white troops than among the colored. It is of interest to note that the rate was twice as high as that of the Army at large (16.24). In Hawaii, syphilis was relatively uncommon. There were 169 primary admissions among approximately 20,000 enlisted men; the rate was 8.68 per 1,000 strength. Syphilis was more prevalent among white troops in Panama than in Hawaii; in the former there were 277 cases, with the admission rate of 14.07. The highest rate for enlisted men (53.40) was in a miscellaneous group of stations that included China, Siberia, Russia, etc. The highest rate among the native troops was for the Porto Ricans (25.69). Among Philippine Scouts, numbering approximately 19,000, there were 195 cases (10.50). The Hawaiian rate was the lowest (4.10) recorded for any troops during the war.

DIAGNOSIS

The diagnosis of syphilis in the Army during the war was conducted along conventional lines and but little new was developed. However, never before were examinations carried out on such a large scale, nor has it been possible before to study data in such masses. The outstanding feature in diagnosis was the attempt at the recognition of syphilis as soon as possible after infection. This explains the relatively high occurrence of primary syphilis. Briefly, the methods used were physical examination, examination of the ulcer for the *Spirochæta pallida,* and serological methods. The luetin test was used scarcely at all. The colloidal-gold test and the cell count were used in selected spinal fluids. The Röntgen ray was used as an auxiliary in cases of suspected visceral syphilis.

The importance of early diagnosis was frequently emphasized and, in this regard medical officers were advised by the Surgeon General as follows:[7]

The matter of prime importance in handling syphilis is to get it at the beginning of the infection. The earlier it is treated the better are the prospects of cure, and the quicker the soldier can be made noncontagious and gotten back to duty. It should be the constant effort to discover syphilis at the earliest possible time, if possible before the development of a possible Wassermann reaction.

To this end, every sore, whether on the genitals or elsewhere, that is open to any suspicion of being a chancre should be repeatedly examined for spirochetes. No determining weight should be given to the so-called specific clinical characteristics of any lesion that might by any possibility be a chancre. Experience has shown that the typical clinical characteristics of the chancre, aside from indolence—and this may be masked by another infection—are often lacking. Any excoriations, papule, nodule, crack, herpetic or other erosion no matter how small, may be an initial lesion of syphilis; and such lesions, as well as ulcers about the genitals—and elsewhere, if there is any reason to suspect them or if they are indolent and not readily to be accounted for—should be searched for spirochetes.

Chancroids in particular should never be accepted as uncomplicated by syphilitic infection. They are likely to have a double infection, and should always be zealously examined for *Spirochæta pallida*. Sometimes, in spite of the most careful search, the spirochetes escape detection in chancroids. For that reason, one can never be sure that a chancroid does not hide a chancre; patients with chancroid, therefore, require watching for the possibility of syphilis, and, when the spirochetes can not be found, should always have weekly Wassermann tests for three or four weeks until the question of syphilis can be decided.

Antiseptics, especially mercurials, render the finding of *Spirochæta pallida* difficult or impossible, and, because of this, it should be routine practice to apply no mercurial dressings, or, better, no antiseptic dressings, to suspicious lesions until the necessary examinations to exclude *Spirochæta pallida* have been made. If any such application has been made to a suspected lesion, the lesion should be thoroughly irrigated with physiologic sodium chloride solution, and a wet dressing of this solution applied for 12 hours or more before examining for spirochetes.

In order to aid in discovering the initial lesion at the earliest moment soldiers who have been exposed should be inspected at intervals of a few days for at least three weeks, and also instructed to be themselves on the watch for suspicious lesions.

Examination for Spirochæta pallida and diagnosis.—To obtain the *Spirochætæ pallidæ* for examination two procedures are of value. In obtaining them directly from the lesion the surface should be wiped with gauze wet with physiologic sodium chloride solution to remove saprophytic organisms, especially the *Spirochæta refringens*. The rubbing should leave a clean oozing surface, not bleeding. Light curettement may be necessary in some cases. Moderate squeezing of the lesion will then cause an exudation of lymph from the deeper portions of the tissues. A drop of this lymph is then touched to a cover glass and placed on a slide, or the fluid may be collected in a capillary pipette. It may be preserved for a few hours by sealing the pipette, or the specimen on the slide may be ringed with paraffin or petrolatum and kept on ice for variable periods up to 12 hours or longer. Delay impairs the validity of the findings, however, and multiplies uncertainties, so that examination should be made at once.

A valuable method, which relieves the observer of much of the responsibility for differential diagnosis of the organism, is glandular aspiration. This can be done on prominent nodes in the satellite adenopathy accompanying the primary lesion. It can also be performed on the indurated base of a suspected chancre. A sterile glass syringe, of 1 c. c. capacity, fitted with an ordinary stout hypodermic syringe needle, an inch or so in length, is sufficient. The skin over the gland is painted with iodine and the gland palpated and fixed between the thumb and forefinger of the left hand. The needle is plunged through the skin into the gland, the penetration of the capsule being indicated by the moving of the gland under the finger when the position of the syringe is changed. The gland is then held firmly while the needle is manipulated enough to macerate the tissue immediately around the point. Aspi-

ration will draw a drop or two of tissue juice into the needle and barrel. The fluid thus obtained is often rich in *Spirochæta pallida*. The method is not especially painful, and is easily borne by the average patient.

The *Spirochæta pallida*, as obtained for study by these methods, has a morphology usually easily recognized by the experienced observer. It is a regular spiral organism, of from 6 to 15 microns in length, with from 3 to 26 turns. The average length is about twice that of a red blood cell, and the usual number of turns is from 10 to 20. It is rather slow moving, which is a distinctive characteristic. A movement in the direction of the long axis and a rotating movement are most commonly observed. The organism retains its clear-cut, regular spiral turns exceptionally well, even at rest—another distinctive characteristic. Long forms bent in the middle are occasionally seen.

From *Spirochæta refringens*, if this is not eliminated by proper cleansing, the *Spirochæta pallida* is distinguished by the fact that *Spirochæta refringens* is obviously coarser and the turns are fewer and less regular. *Spirochæta refringens* does not keep its corkscrew shape so well as *Spirochæta pallida* when at rest, and when in motion moves much more rapidly than the *Spirochæta pallida*. *Spirochæta dentium*, seen in mouth preparations, is much more minute than the *Spirochæta pallida*. Fibrin spirals have been mistaken for syphilitic spirochetes by inexperienced observers. In general it may be said that while the recognition of the organism of syphilis is not an affair for the tyro, a moderate amount of experience on the part of the examiner, coupled with the presence of numerous organisms of the above-described type in a given preparation made under favorable conditions, is sufficient for a diagnosis of syphilis and the institution of appropriate treatment. Failure to find them, however, is no evidence that the lesion is not syphilis.

In all suspected cases Wassermann tests should be made. It should be made a general rule that the first finding of a positive Wassermann reaction should immediately be confirmed by a second, but it is not necessary to delay beginning treatment until the second report is received. For the first 10 days after the appearance of the chancre the Wassermann reaction is usually negative. It is at this critical period that the establishment of the diagnosis of syphilis by demonstration of the specific spirochetes is of such importance, because it enables us to begin treatment while the infection is still relatively localized and can usually be aborted by thorough treatment. In suspected chancres in which spirochetes can not be found Wassermann tests should be made at intervals of a week, for a month, before it is decided finally that the case is not syphilis. In cases in which the spirochetes are found a Wassermann test should be made at the outset, and if it is not positive should be repeated at weekly intervals for the first few weeks to see if, in spite of treatment, it becomes positive. Further Wassermann tests should be made at about monthly intervals.

In no cases should specific treatment be started until a positive diagnosis of syphilis has been made.

Though the Surgeon General's Office recommended certain laboratory methods, much latitude was allowed the officers in charge; therefore, methods used by all laboratories were not identical. Particularly was this true of laboratories in the United States. In the American Expeditionary Forces the instructions[11] were that a man with a suspicious sore should be sent to the laboratory of the division, where preparation for staining and dark-field examinations were to be made by the pathologist, a consultation obtained with the urologist, if feasible, and the man returned at once to his unit with an immediate report of findings. Local application of mercurial preparations or cauterization of the sore was forbidden before smears for microscopic diagnosis were taken, and failure of the microscopic examination to demonstrate *Spirochæta pallida* was not to be regarded as final until several additional smears had been made.

Twenty-eight and four-tenths per cent of the admissions for syphilis were diagnosed in the primary stage. This was accomplished by examination of the sore for the *Spirochæta pallida;* 50.4 per cent were diagnosed in the secondary

stage, accomplished by means of physical examination, confirmation by the results of the Wassermann complement fixation test or some modification thereof.

No test was considered positive unless there was complete inhibition of hemolysis, except in the early primary cases when less inhibition was considered positive in a few cases. Four degrees of reaction are noted in reports from the Army laboratories. A positive reaction is reported as double-plus (+ +), and means that there is absolute inhibition of hemolysis. A doubtful reaction is reported as plus (+) or plus-minus (+ −), the former term indicating that there was over 50 per cent inhibition of hemolysis, the latter that there was less than 50 per cent inhibition of hemolysis. A negative reaction is reported as minus (−). In most civilian laboratories the results of the Wassermann test are reported as four plus (+ + + +), three plus (+ + +), two plus (+ +), plus (+), plus-minus (+ −), and negative (−). The four-plus reaction corresponds to the Army double plus, the three plus and two plus to the Army plus, the plus and plus-minus to the Army plus-minus.

Although, as generally performed, the Wassermann test is not a true specific reaction, the work of Noguchi[12] and Craig and Nichols[13] had proved that, with antigens prepared from pure cultures of *Spirochæta pallida*, complement fixation can be obtained with syphilitic sera, and that in such instances the reaction is really a specific one, due to antibodies in the patient's blood serum against the spirochete.

Examination of the cerebrospinal fluid, not only in cases presenting neurological signs and symptoms, but also as an indicator of cure of the syphilitic infection, was the practice in the Army. Negative findings in the fluid is a requisite of cure in the Army standard index.

The vast majority of chancres were genital; however, extragenital chancres occurred, and were of special interest to the military service in determining the status of the individual officer or soldier as to whether or not the illness was in line of duty. The number of such cases was exceedingly small; they were found more commonly among the medical personnel as the result of infection by patients. Lambie[14] made a survey of approximately 30,000 Army syphilitic registers and found 139 cases of extragenital infection.

COMPLICATIONS, SEQUELÆ, AND CONCURRENT DISEASES

Since practically no tissue of the human body is immune to the syphilitic virus, the number of possible complications is large. Complications and sequelæ, however, develop relatively slowly and since the average length of service per man in the Army during the war was approximately a year,[15] and the average period of time in hospital for syphilis was 28.7 days, it is apparent that the Army's World War statistics are of little interest in this connection. As previously stated, complicated syphilis, when detected, was a cause of rejection from military service; however, many uncomplicated cases were accepted for service. Such complications as cardiovascular syphilis and syphilis of the nervous system were but seldom reported.

TABLE 46.—*Primary admissions, complications, sequelæ, and concurrent diseases reported with 12,843 cases of syphilis in the United States Army, April 1, 1917, to December 31, 1919*

Diseases (primary and secondary)	Number of cases	Diseases (primary and secondary)	Number of cases
Acute articular rheumatism	126	Mental deficiency	95
Chancroidal infection	3,687	Dementia præcox	45
Gonococcus infection	7,498	Chorioiditis	56
Arthritis	653	Iritis	307
Leukemia	2	Keratitis	84
Hodgkin's disease	3	Retinitis	34
Anemia, chlorosis	5	Pericarditis	6
Alcoholism, acute or chronic	29	Endocarditis	13
Drug addiction	27	Aortic insufficiency	36
Fracture, faulty union of	17	Aortic stenosis	9
Locomotor ataxia	62	Mitral insufficiency	122
Multiple sclerosis	5	Mitral stenosis	32
Apoplexy	71	Myocarditis and myocardial insufficiency	95
Facial paralysis	15	Angina pectoris	5
Paraplegia	8	Aneurism	12
Paralysis, others	44	Aortitis	42
Epilepsy	66	Tachycardia	41
Neurasthenia	57	Ulcer of the stomach	14
Neuritis	68	Bones, other diseases of	165
General paralysis of the insane	79		
Duodenal ulcer	8	Total	12,843
Cirrhosis of the liver	13		
Nephritis:			
Acute	32		
Chronic	65		

PROGNOSIS

For reasons above stated, the World War statistics are of but little or no value in determining the prognosis of syphilis. For the total Army during the World War there were recorded 51,119 deaths from disease. For syphilis, both among primary admissions and concurrent diseases, there were 317 deaths; that is, 0.54 per cent. Syphilis ranked twenty-first on the list of the most common causes of death among primary admissions for disease and if all cases, both primary and concurrent, be included, it ranked fifteenth. From the military point of view, the prognosis of syphilis was better than, for example, scarlet fever, in that, although there were about one-sixth as many cases of scarlet fever there were approximately twice as many deaths, while time lost from duty was about twice as great per case. As a rule, syphilitics were admitted to hospital and held there during the contagious stage and while physically disqualified for duty. They were then returned to their organizations for prolonged treatment, and but rarely were readmitted to sick report. And as shown under treatment in this chapter, since the course of treatment was a long one, the total interference with duty can not be determined.

From previous experience, especially since 1911, when the Army syphilitic register was inaugurated, the Surgeon General prescribed a standard cure for syphilis:[16]

> One year of observation must elapse after all treatment has been stopped. During this year there must be no clinical evidences of syphilis, several negative Wassermann reactions and no positive ones. At the end of the year a complete physical and laboratory examination, including that of the spinal fluid and a provocative blood Wassermann reaction must be negative. If all these requirements have been fullfilled, the case can be closed as "cured" and the register sent in.

Among enlisted men, white and colored, during the war there were treated 19,024 cases of primary, 34,787 cases of secondary, and 10,984 cases of tertiary syphilis, but it can not be stated how many were cured. It is difficult to say

positively that a patient is cured of syphilis. This may require years of observation, including careful scrutiny at the necropsy table by a competent pathologist. However, from the military viewpoint it may be said that the prognosis of syphilis in the Army during the war, and based upon the records only, was good, as there were but 143 deaths and 3,318 discharges for disability among approximately 67,000 cases of syphilis, with an average period of hospital treatment amounting to 28.7 days.

TREATMENT [a]

TREATMENT OF THE CHANCRE

Excision of the chancre is a procedure which theoretically should be useful, on the ground that it removes the important focus of infection. And when the location of the chancre is such that its excision will not cause deformity, surgical excision may be done; but excision of the chancre does not abort syphilis. The excised chancre should be preserved and sent for laboratory examination. Until the search for spirochetes is ended, the chancre should be treated only by cleansing with saline solution and covering with a compress wet with the same solution. As soon as spirochetes are demonstrated, if the chancre is not excised, it should receive an inunction of 33 per cent calomel ointment twice daily for a week; it should be kept clean and protected by a calomel ointment or some bland protecting dressing.

SYSTEMIC TREATMENT

In the presence of early syphilis, treatment should be immediately started and vigorously pushed. It should be with both arsphenamine [b] and mercury. Before beginning there should be a preliminary survey of the patient's physical condition. Patients with acute febrile diseases or with diseases of the liver, kidney, or vascular system—when they are nonsyphilitic in origin—should be given arsphenamine with caution.

Arsphenamine [b]

There is agreement among syphilographers that the most effective time for producing radical results with arsphenamine is in the first few weeks of syphilis—best before the Wassermann test becomes positive—and that arsphenamine should be pushed at this time.

The normal dose should be on the basis of 1 decigram of arsphenamine for each 30 pounds of body weight, i. e., from 4 to 6 decigrams for patients of ordinary weight. The first dose should be one-half the normal dose. Administer at intervals of from five to seven days. Six doses constitute a course.

It is possible that in cases seen before the Wassermann test has become positive, one such course of arsphenamine combined with mercury may cure. But this is not safe to assume, and, in the light of our past knowledge of syphilis, it is advised even in these cases to repeat the course of arsphenamine and mercury treatment at least once after a rest period of from six to eight weeks.

[a] Based upon A Manual of Treatment of the Venereal Diseases for the Use of Medical Officers of the Army. Prepared under the direction of the Surgeon General, 1917.

[b] Arsphenamine is the official name now applied to the drug formerly called salvarsan.

Such patients should be subsequently watched for a year with monthly Wassermann tests and treated should any evidence of syphilis be discovered.

In all cases seen after the Wassermann test has become positive the first course of treatment should be followed by a second after four to six weeks' rest. And it is safest to give at least a third similar course after an interval of two months even in the most promising of cases.

In all those cases in which a positive Wassermann test or any other evidence of syphilis remains, further courses of arsphenamine and mercury should be given at intervals similar to the foregoing, the persistence in treatment to be determined by the findings in the individual case.

In place of arsphenamine, neoarsphenamine can be used in 50 per cent larger doses. It may be somewhat less effective, but the difference is not sufficient to allow of dogmatic statements on this point.

It may be repeated that the use of arsphenamine is to be combined with that of mercury in the attempt at cure of syphilis; and that reliance is not to be placed on arsphenamine alone.

Preparation and Care of Patient

The urine should be examined before each injection of arsphenamine. Arsphenamine should be given with the patient's stomach empty, or nearly so. The treatments are best given at noon or in the early afternoon, the patient omitting lunch. He should remain quiet for the rest of the day—best in bed—and should take no food until the next morning.

Reactions from Arsphenamine

As a rule the administration of arsphenamine is followed by no symptoms whatever. Occasionally, however, reactions occur from it; these vary in severity from slight, evanescent distress to symptoms of the gravest poisoning.

To some extent, perhaps, these reactions are due to individual hypersensitiveness to the drug. There is good reason to believe, however, that the severe reactions are chiefly produced by impurities in the drug, due to faults in manufacture, or sometimes to oxidation produced by carelessness in technique of administration.

The reactions may be divided for consideration into early and late; the early reactions occurring from the very time of injection to 6 or 8 hours afterward, and the late occurring from 1 to 4 or 5 days, and, occasionally, even longer afterward.

The early reactions have the symptoms of acute poisonings; the late, symptoms of organic disturbances that have resulted from the slower action of a poison.

Early Reactions

Nausea.—The commonest reaction after arsphenamine is a feeling of malaise with some nausea from five to seven hours afterward. Not infrequently this amounts to a chill, followed by slight fever and more or less severe vomiting. These symptoms disappear in a few hours.

They do not constitute a contraindication to the further use of the drug, but they should suggest that more care than usual be exercised to see that,

before administration, the bowels have been cleaned out and the stomach is empty and that, afterward, the patient rests without food until the next morning.

Febrile reaction.—Rarely these reactions are more severe. The temperature may go to from 101° to 104° F. with headache and general pains, especially of the legs and back, diarrhea as well as nausea and vomiting, and an eruption of urticaria or toxic erythema. The treatment is rest in bed and a liquid diet until symptoms have subsided. The pain may be controlled by a few doses of salicylates. No more arsphenamine should be given in these cases until several days after all symptoms have disappeared, and any further administration of the drug should be in relatively small doses and at intervals of not less than a week.

Temporary albuminuria.—It is not uncommon to find a trace of albumin and a few casts in the next morning's urine after an injection of arsphenamine. This is not a contraindication to the further use of the drug unless the albumin is present in considerable quantity and there are more than half a dozen casts to the slide.

Immediate acute reaction.—The early reaction which in rare cases accompanies or immediately follows the administration of arsphenamine is that of an acute poisoning, characterized by intense congestion from vasomotor disturbances; this is the so-called anaphylactoid reaction of arsphenamine. It is probably due to impurities in the drug. In these cases the patient suddenly—perhaps before the injection is finished— manifests symptoms of distress. He may first notice a taste of garlic or ether, or of a metallic substance. An erythema appears on the neck and spreads thence over the face, and the jugular pulse is exaggerated and rapid. He complains of faintness; the pulse becomes weak and the respiration labored. The face is puffed and congested; the pupils dilate; there is a feeling of constriction in the throat; and there may be edema of the glottis, which fortunately is very rarely fatal. There is tightness in the chest, and especially precordial distress. The pulse may become imperceptible, the patient cyanotic, and syncope may occur. Altogether the picture is extremely alarming in the severe cases, but fortunately the symptoms as a rule quickly improve, and recovery nearly always takes place.

These cases promptly respond to the injection of from 1 to 2 c. c. of 1:1,000 solution of adrenalin, which may be repeated at intervals of 20 or 30 minutes, if required, until the symptoms subside. In preparation for this emergency a sterile hypodermic syringe with 2 c. c. of adrenalin solution in it should always be at hand when arsphenamine is given.

The occurrence of this reaction does not preclude the further use of arsphenamine; but is suggests that careful control of the patient's preparation should be exercised, that the technique should be reviewed, and that the preparation of arsphenamine should be investigated.

Late Reactions

Lowering of general health.—Occasionally during a course of arsphenamine a patient's general health becomes lowered without other evidence of organic disturbance. There is lassitude and, perhaps, headache; the appetite is poor

and the patient falls off in weight. Such symptoms—likely to be overlooked because of their insidiousness—should lead to careful consideration of the case. Patients who are doing well under specific treatment show it in an improvement in their general well-being. If this lowering of the health progresses under arsphenamine, it should be discontinued. The patient should be relieved from duty, placed on a liberal, perhaps forced, diet, given tonics, and his elimination stimulated by abundance of water and the use of laxatives or cathartics; also he should be carefully examined for other diseases.

Erythema and dermatitis.—In rare cases, patches of scarlatiniform erythema develop from 12 to 24 hours after arsphenamine; these are usually accompanied by evidence of kidney irritation. The appearance of areas of scarlatiniform erythema is an indication that arsphenamine should be stopped until well after these symptoms have disappeared, and that its further use should be very guarded.

These preliminary manifestations of intoxication usually disappear spontaneously in a few days, although rarely they develop into the severe cases. If arsphenamine is continued in spite of these warnings, there is likely to develop a universal exfoliative dermatitis with nephritis. In extreme cases the nephritis is severe, accompanied by high fever, diarrhea and bronchopneumonia, and the result may be fatal. The same measures, to a greater degree, are indicated here as already suggested for lesser intoxication—complete rest, support of the patient's strength by an abundant diet, and stimulation of elimination.

Nephritis.—Severe nephritis with its sequelæ may occur without skin symptoms. For this reason the urine should always be carefully watched while arsphenamine is given.

As stated above, a transient albuminuria with a few casts is common the next morning after an injection of arsphenamine. If this promptly disappears, it is not a contraindication to the continuance of the injections.

Again, albuminuria due to syphilitic nephritis is not very rare. The evidence of the characters of such an albuminuria is that it is quickly benefited by arsphenamine as by other specific treatment.

Persistent evidence of nephritis developing in the course of arsphenamine administration is another matter. It requires that the course be stopped and not resumed until the nephritis has disappeared; and then the further use of the drug must be with extreme caution. If these precautions are neglected the case is likely to develop into one of severe, permanently disabling, or fatal type.

Jaundice.—In rare cases jaundice occurs in the course of the use of arsphenamine. It is always a sign of serious intoxication and should cause immediate, careful attention to be given to the case. Such cases may go on to acute yellow atrophy of the liver with fatal termination. They require in the way of treatment measures for overcoming intoxication of the sort already outlined. The larger proportion of jaundice cases are said to follow neoarsphenamine.

Hemorrhagic encephalitis.—This, fortunately, is one of the rarest, as it is one of the most serious, of arsphenamine accidents. The cases begin from two to four days after arsphenamine with severe headache, mental confusion, and dullness; then, usually, convulsions, coma, and death in a few days.

The pathology of cases succumbing from this type of arsenical intoxication shows as a rule the following features: There is characteristically an acute hemorrhagic encephalitis with softening of the cerebral tissue and with punctate hemorrhages, especially in the basal ganglia, pons, and medulla, but also involving the cerebral lobes adjacent to the lateral ventricles and less frequently the cerebellar tissue. With this is associated an acute ependymitis, especially in the lateral ventricles, with hyperemia and punctate hemorrhages. There may be general cerebral congestion and edema. Acute nephritis may be present but is not constant. Degenerative lesions may develop in the liver, sometimes giving a picture resembling acute yellow atrophy.

Treatment of these cases consists of vigorous elimination, which may include withdrawal of blood, and the intramuscular use of epinephrin in full doses.

Herxheimer reaction.—In the presence of syphilitic lesions in vital structures, the administration of arsphenamine which, presumably from the liberation of spirochetal endotoxins, causes a temporary engorgement of the syphilitic lesion, may produce serious symptoms of pressure, of obstruction, or of other impairment of function. This reaction is most likely to occur with early cerebral lesions, producing pressure symptoms, which may cause paralysis, coma, and even death. As a rule, while the symptoms are alarming, recovery takes place.

Similar reactions, producing symptoms of a character dependent on the location of the syphilitic focus, may occur with syphilitic lesions of the viscera, or of the circulatory system, particularly in myocarditic coronary arteritis and aortitis.

To guard against these accidents, when there is reason to suspect lesions in any of these structures, particularly in the brain, mercury and iodide should be vigorously given for several days before arsphenamine is started, if the symptoms are not so urgent as to warrant taking the risk of a Herxheimer reaction, and then the use of arsphenamine should be cautiously begun, with small doses, and only after two or three injections should full doses be given.

In these reactions treatment is symptomatic.

In general, the careful man is likely to attach undue importance to minor symptoms arising in the course of arsphenamine administrations, and to be influenced too readily by them to give up its use in the particular case. On the other hand, a reasonable caution in the face of symptomatic warnings of arsphenamine intoxication demands care in its further use in such cases.

Recurrences of Nerve Involvement

It is an occasional experience to see, with patients who have had insufficient treatment with arsphenamine or mercury, a recurrence of syphilis in a nerve or the brain or cord, producing symptoms of impairment of function in the particular structure involved. These recurrences are most likely to be observed in the auditory or optic nerves, producing more or less damage to hearing and vision. While these are mentioned here, they are not manifestations of arsphenamine poisoning. They are due to syphilitic infiltrations and occur, as well, in patients who have had no arsphenamine. They require vigorous specific treatment with mercury, iodide, and arsphenamine—especially the latter in

patients who have already had arsphenamine. Of course, when these recurrences are cerebral as in the case of involvement of the optic nerve, due care must be exercised with arsphenamine to avoid a Herxheimer reaction

Technique of Arsphenamine Administration

The fundamental principle of administering any form of arsphenamine is a rigid asepsis, and only extreme conditions justify its administration when this is not obtainable. The apparatus should be boiled for 20 minutes. It is important that freshly distilled water be used for arsphenamine solution. Thirty c. c. of water per decigram of arsphenamine is a safe dilution. The ampule should be sterilized by immersion in a strong antiseptic solution, such as mercuric chloride, 1: 1,000, and then should be immersed in 95 per cent alcohol in order to be sure it is not cracked. If it has been immersed in mercuric chloride it must be carefully wiped dry before it is opened. It must never be sterilized by boiling.

The drug is first dissolved in about 50 c. c. of water. The American preparation, arsenobenzol, requires hot water for its solution, and is safely dissolved in hot water. The other preparations dissolve in water at room temperature and should not be heated, because of the danger of the formation by heat of highly toxic compounds. The direct solution of arsphenamine is a strongly acid solution, which must be neutralized and diluted before injection. Neutralization is accomplished after all the arsphenamine is dissolved by a 15 per cent freshly prepared solution of sodium hydroxide, which should be added drop by drop. Arsphenamine is precipitated from the solution by the alkali, but redissolves as soon as the suspension becomes slightly alkaline. The point at which this occurs can be gauged with sufficient accuracy if the sodium hydroxide is added carefully and mixed after each drop or two. Since arsphenamine oxidizes easily, it should not be violently shaken in preparation. As soon as the arsphenamine has redissolved, yielding a clear yellow solution, it may be filtered through wet sterile cotton in a funnel directly into a graduated container; then warm or cold distilled water is added to the proper dilution and to approximately body temperature. Care must be taken to fill the tube attached to the container with physiologic sodium chloride solution and to expel all air bubbles before the arsphenamine solution is filtered into the container.

In the event that the arsphenamine precipitates somewhat on dilution, it may be redissolved by another drop or two of the sodium hydroxide. If the preparation has been made too strongly alkaline, a drop of dilute hydrochloric acid may be added and the neutralization repeated. The drug should be administered promptly after preparation, and no more than enough for use on the patients to be treated at the time should be prepared.

The technique of injection of the solution is comparatively simple, and the older custom of making an incision to find the vein, with its resultant scarring, has been abandoned by skillful operators. A variety of needles has been proposed, but the Schreiber 18-gauge with thumb guard and a proper adapter, or even a plain needle, will answer all purposes. In difficult cases a finer needle may make it much easier to get in the vein. The skin over the field of opera-

tion, preferably in the region of the large cubital veins, is sterilized as for a surgical procedure, but if tincture of iodine is employed it is desirable to remove it with alcohol in order that the vein may be more easily seen. The injection should be given with the patient lying down and the veins distended by encircling the arm with a tourniquet.

In nervous patients, local anesthesia may be used to advantage. The needle is pushed directly through the skin over or to one side of the vein and then introduced into the vein. As soon as the blood returns freely through the needle, the adapter attached to the tube of the container is fitted to the shoulder of the needle, the tourniquet is released, and the injection begun by elevating the container about 2 feet. As a rule assistance is desirable, since the operator is occupied by keeping the needle in position in the vein. Failure to enter the vein is apparent by this method, before injection is begun, through the imperfect flow of blood through the needle. The saline solution contained in the tube allows sufficient warning of the infiltration of the tissues before the arsphenamine solution reaches the needle point. Various forms of apparatus which inject saline solution as a test before beginning the injection of the arsphenamine are not essential and are often complicated. A glass telltale in the rubber tube permits the operator to watch the progress of the injection. When the injection is completed, the lowering of the container below the level of the arm before the needle is withdrawn will aspirate a small amount of blood from the vein and prevent the escape of solution into the tissues.

Recent investigations have shown that the danger from intoxication with arsphenamine is much greater when it is administered in concentrated solution or is injected rapidly. For this reason it should be used in weak dilution and slowly injected.

Infiltrates, if they occur, are usually trivial, provided the operator has been on his guard. The escape of arsphenamine into the subcutaneous tissues is indicated by a burning sensation, which the patient should be warned to report. The reaction which ensues when arsphenamine is injected around the vein is inflammatory, with induration and infiltration, and may, if severe, progress to a slough. Arsphenamine infiltrates should be treated by wet dressings, ice bag, and, after inflammatory symptoms subside, by massage and passive movement. An alarming degree of involvement may subside with practically no damage after several weeks or months. Thrombosis of the vein is an infrequent complication if the drug has been properly diluted, and should be treated on general indications.

Technique of Neoarsphenamine Administration

The original administration of neoarsphenamine, in dilutions similar to those used with arsphenamine, has been greatly simplified by the injection of the dose in concentrated solution. In this procedure, the dose of neoarsphenamine is dissolved in 10 c.c. of freshly distilled sterile water at room temperature—not hot water. The solution is drawn up into an all-glass syringe and administered as an intravenous injection after the usual preparations. The method is rapid and extremely convenient, and its applicability to difficult cases is apparent.

The solution of neoarsphenamine, being already neutral, requires no addition of sodium hydroxid. Care must be taken to avoid infiltrates with the concentrated solution, but in general infiltrates with neoarsphenamine are apt to be less serious than those with arsphenamine.

The French preparation novarsenobenzol (Billon) was used almost exclusively with the American Expeditionary Forces. The results were satisfactory. It was given in concentrated solution, the ordinary dose in 2 c. c. of water, and the ease of administration of this small injection proved of great practical advantage in the field.

MERCURY

For the cure of syphilis, arsphenamine and mercury should be combined, and at the same time with each course of arsphenamine a vigorous course of mercury should be given. This should begin before or at the same time with or within a few days after the first dose of arsphenamine.

A course of mercury should consist of 9 or 10 weekly injections of an insoluble salt, of from 24 to 30 injections of a soluble salt at two-day intervals, or of from 40 to 50 daily inunctions of mercurial ointment. The administration of mercury either by inunction or by intramuscular injection is effective; and in the selection of either method one may be properly influenced by considerations of convenience and practicability.

Inunctions

If inunctions are used, it is necessary to see that they are properly performed. Patients can not be trusted to give themselves inunctions; but they can very readily do it for each other by sitting one behind another and having each man rub the back of the man in front of him. From 4 to 8 gm. of mercurial ointment may be used for a daily inunction. It is desirable before the inunction to wipe off the area to be rubbed with alcohol or to wash it lightly with soap and water and dry. The ointment should be rubbed in slowly and gently with the palmar surface for 20 or 30 minutes, or until the ointment is practically absorbed. Any excess should be allowed to remain on the skin. After six inunctions a day should be skipped and the patient allowed a bath.

In giving inunctions, hairy surfaces and the thin skin of joints should be avoided, and the same area should not be used often enough to produce dermatitis. The two sides of the back furnish the most tolerant areas. The sides of the abdomen and of the chest, and the inner surfaces of the thighs, the arms, and the forearms may all be used.

Injections

For injections, the preferable insoluble preparations are mercuric salicylate or calomel in oil, or metallic mercury in the form of gray oil. Perhaps the best proportion for the salicylate or calomel suspension is 20 gm. (weight) in sterile olive oil or thin liquid petrolatum, enough to make 100 c. c. (volume). A good formula for mercurial oil (gray oil) is redistilled mercury, 20 gm.; chlorbutanol, 2 gm.; anhydrous lanolin, 30 c. c. and liquid petrolatum, enough to make 100 c. c.

The intramuscular dose of calomel, salicylate, and metallic mercury are the same. These three preparations, being of the same strength, have the advantage of having the same dose. The average dose of either, for an adult man, is 0.06

gm. weekly; by graduations the dose may be increased to 0.12 gm. weekly, or with caution even higher.

The curative action of the injection of soluble salts of mercury is perhaps less than that of the insoluble. However, they are free from the dangers of cumulative effect which are inherent in the insoluble salts; and in emergencies, when there is need to get prompt, certain, and vigorous effect of mercury, they are of great value. Mercuric chloride, mercuric succinimide, or mercuric benzoate are the most useful soluble salts for injections. Good preparations are 1 or 2 per cent mercuric chloride or 1 or 2 per cent mercuric succinimide with 1 per cent sodium chloride by weight in distilled water. The average dose is 0.015 gm. into the muscle of the buttock every second day. Mercuric benzoate is given in 2 per cent solution with 2.5 per cent sodium chloride, average dose 0.015 gm. every second day.

The American Expeditionary Forces used as routine treatment intravenous injection of 1 per cent solution of mercuric cyanide. The average dose is 1 c. c., representing 0.01 gm. of mercuric cyanide, given daily.

Technique of Injections

For intramuscular injection, a syringe such as the all-glass Lüer hypodermic syringe with a 1½-inch, 20 or 22 gauge needle is used. The needle should have a slip shoulder to permit of its easy detachment from the syringe. Sterilization of the skin with tincture of iodine is sufficient; emulsions once sterilized will remain so with reasonable care in their handling. In military service the syringe and needle should be sterilized by boiling, or by liquid phenol, and the water or phenol removed by filling the syringe first with alcohol and then with ether.

The site of the injections is usually in the upper outer quadrant of the buttock, care being taken to avoid the region of the sciatic nerve or the structures about the hip joint. They can also be well given in the upper inner quadrant of the buttocks. Injections are made alternately into each buttock.

The needle with the syringe empty should be introduced to its full length, and the syringe then detached and filled with the necessary dose. This introduction of any empty needle is a safeguard against making an injection into a vein. If the dry needle should be in a vein, on detaching the syringe, blood would well up through it; if the needle remains free from blood, as is nearly always the case, there is reasonable security against introduction into a vein.

In general, in order to prevent leakage of the emulsion, it is desirable to introduce the needle on a slight slant in the tissue. This may be accomplished by drawing downward on the skin of the buttock, which permits a valve action as soon as the needle is withdrawn and the hand released. The injection if made slowly is practically painless. The development of infiltrates and nodules of any considerable size, or in any number, during a course of injections, is either a reflection on the operator's technique or shows the case to be unadapted to this form of treatment. When an insoluble salt has been used, each of these nodules represent encapsulated mercury, and materially increases the danger of cumulative action. Daily massage by the patient will usually reduce them in a short time. If their formation can not be prevented the patient should be given injections of a soluble salt.

Care of Patient While Taking Mercury

Mercury as well as arsphenamine throws a burden on the kidneys; and patients under intensive treatment with mercury and arsphenamine should have the renal functions carefully watched. An examination of the urine for albumin and casts should be made weekly, and the development of definite nephritis during a course of treatment is an indication to stop. Treatment may be undertaken again after the nephritis has disappeared, but must be less vigorous than before and must be carefully watched.

Care of the mouth is a part of the general care which a syphilitic should have. Dental troubles should be looked after and the patient instructed in the care of the teeth. When a syphilitic patient is sent to the dentist, the dentist should without fail be notified that the patient has syphilis in order that he may safeguard himself against infection. A dentifrice should be used, and it is a good plan to have the patients as a routine use an oxidizing mouth wash such as a one-half saturated potassium chorate solution, or a diluted solution of hydrogen peroxide. When the gums are soft or unhealthy, a good astringent application is tincture of myrrh to be painted on two or three times daily, after brushing the teeth.

Salivation

If salivation occurs, the mouth should be cleaned at short intervals by washing with hydrogen peroxide solution or half saturated potassium chlorate solution. Dobell's solution may also be used, and, while less effective, it has the advantage of being soothing. Pledgets of cotton or gauze moistened with boric acid solutions placed between cheeks and teeth give comfort and get rid of exudate. Atropine is useful, given to the point of reducing salivary secretion. If the patient has been using inunctions, he should, in order to get rid of mercury in the skin, be greased with an oil and then well washed with soap and water and put in fresh clothes. He should have a soft, nutritious diet, be protected from exertions, and given the care for exhausting illness. In particular, he should be given an abundance of water.

Estimating the Course of Cases

During the early course of syphilis, a Wassermann test should be made at monthly intervals, and after it has apparently become permanently negative, it should still be repeated at intervals of two or three months for at least a year. It should be remembered that the Wassermann test is not likely to be positive for the first 10 days of the chancre. After it becomes positive, the obtaining of a single subsequent negative reaction means little; it must remain negative over a period of months to justify the conclusion that it is permanently negative.

In estimating the effect of treatment on syphilis, not only the disappearance of specific clinical symptoms and of the positive Wassermann reaction should be considered, but the patient's general well-being as well. In zeal to sterilize a patient of spirochetes the effect of the treatment itself on the patient should not be overlooked, and treatment should not be pushed beyond the point at which the patient is able to tolerate it without distinct lowering of his general physical tone.

A patient may be regarded as free from the necessity for further observations or treatment who, under observation and with Wassermann tests at intervals of two months, has remained free from all evidence of syphilis for a year.

There is room for difference of opinion as to the advisability of spinal puncture or a provocative injection of salvarsan with a subsequent Wassermann test in every case before discharge. Conservative practice reserves the use of these diagnostic measures to cases in which there are special indications.

LATE SYPHILIS

The late manifestations of syphilis in the Army are less common than the early. Gummatous lesions in the skin or bones or elsewhere, which may be cured without leaving any serious damage to the body, do not constitute a difficult clinical problem. In old cases of this sort there is not the need for the intensive treatment administered in early cases. These patients should have mercury and potassium or sodium iodide until their lesions are cured. How much further treatment should be carried is a matter for judgment in the individual case. The deep lesions of late syphilis—syphilis of the viscera, of the vascular system, especially of the heart or aorta, and of the central nervous system—indicate such serious impairment of the body that these patients will not be able to endure the strain of military life in the field. If the lesions in such cases can be controlled, it may be practicable to find duties for which the patients are still fit; otherwise, they should be considered for discharge.

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CHAPTER VIII

THE DIARRHEAL GROUP OF DISEASES [a]

The diseases which may be grouped together as inflammations of the intestinal tract, and which possess in common the symptom diarrhea, were of much less importance during the World War than during any previous major conflict of which we have record. It will be the main attempt of this chapter, therefore, to show not only the fact of the greatly decreased incidence of these diseases as compared to that of earlier wars, but to study the causes of this decrease and to deduce, if possible, from this study the lines along which further progress in their prevention may be made.

In the comparison of the rates for the diarrheal diseases obtaining during the World War with those of earlier wars we are at once faced with a difficulty arising from differences in nomenclature. The last few decades have been so fruitful of discoveries in the pathology and etiology of disease and in advances in the exactness of clinical diagnosis that the significance of many a diagnostic term as understood to-day is widely different from that accepted only a short time ago. The modern conception of dysentery is that of a clinical entity or complex characterized by an increase in the number of stools, which contain pus, mucus, and blood, accompanied by abdominal pain and tenesmus. This symptom complex may be induced by several known specific agents, of which the most important are the dysentery bacilli and the *Entamœba histolytica*. Of the dysentery bacilli there are several well recognized, more or less nearly related strains, and possibly other bacteria such as the paratyphoid group organisms may at times cause the same group of symptoms. Conditions permitting accurate diagnostic work, the Surgeon General accepts the diagnosis "dysentery" only when supported by evidence as to the specific causative organism. Under war conditions it usually proved impossible to carry out the laboratory studies necessary to such proof and hence by far the greater number of cases of dysentery reported during the war period were unclassified etiologically. A minority, however, were reported as of bacillary or amebic origin. Headings are found in the war tabulations for balantidic dysentery and for dysentery due to other protozoal agents.

In addition to the dysenteries properly so called, there were reported during the war a large number of cases under the headings "diarrhea," "enteritis," and "colitis," the two latter combined in the tabulations. It is self-evident on account of the clinical character of these conditions that a certain number of cases recorded as diarrhea or as enterocolitis actually may well have been dysentery, and, conversely, that some of the cases recorded as "dysentery, unclassified" might better have been called diarrhea or enterocolitis had a strict etiological classification been possible. That in general, however, the

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

distinction between the dysenteries and the nonspecific diarrheal diseases is a valid one on clinical grounds there can be no doubt as will be shown later.

In the earlier records of the United States Army little attempt seems to have been made to distinguish accurately the different types of "intestinal flux." Diarrhea, dysentery, enteritis, and colitis, as well as other now archaic diagnostic terms, were used evidently more or less interchangeably. In the Medical and Surgical History of the War of the Rebellion,[1] the "fluxes" are divided into four groups: Acute and chronic diarrhea and acute and chronic dysentery. Modern diagnostic criteria were not sufficiently in use during the period of the Spanish-American War and the Philippine insurrection to make the statistics of that period much more valuable in the differentiation of the various types of intestinal disease than were those of earlier years. Indeed, in spite of increased diffusion of knowledge and of greatly increased laboratory facilities, experience during the World War has shown that under field conditions—and the greater number of these cases must be expected to occur during active campaigning—accurate differentiation is impossible. For this reason comparisons between the incidence of diarrheal diseases in the World War, and that in earlier conflicts must necessarily be based on totals of the entire group. Nor is this necessarily an unscientific or illogical method of comparison for, so far as may be said at present, the methods of transmission of the diseases of this group, varying as they do clinically and etiologically, are essentially the same. We believe that they are all acquired by the ingestion of infected food or drink [b] and that consequently the underlying predisposing causes and the necessary preventive measures must be considered to be the same for all these diseases however different the specific etiology of individual cases.

Returning to the question of the nomenclature of these diseases, it is evident that in spite of the probability of some confusion in recent statistics, and of the impossibility of separating from the statistics of the past any groups comparable to those of modern tables, there can be little doubt that in the statistics of the World War the diarrheal diseases can be divided into two clinically different groups, on the one hand those which were reported as dysentery on clinical grounds and on the other those cases which were perhaps more loosely classified as diarrhea, colitis, or enteritis. The distinction between these two groups originally made by the clinicians in the individual cases is emphasized and confirmed by the study of the incidence of the two groups month by month, and by a comparison of the severity of the cases as shown by the average number of days lost from duty per case. Table 47 shows the monthly incidence rates of these diseases for the white enlisted men on duty in the United States for the period of the war. Inasmuch as these figures are not influenced by sharp variations in sanitary conditions such as occurred during operations at the front in France, they furnish a better means of comparing the varying incidence of disease than would the figures for the entire Army. The rates under the heading "Dysentery (all)" include all specifically diagnosed cases of dysentery and all cases of "Dysentery, unclassified."

[b] With the possible exception of diarrheas believed by some to be due to chilling of the abdomen.

TABLE 47.—*Diarrheal diseases. Primary admissions, white enlisted men in the United States, April, 1917, to December, 1919. Annual rates per 1,000 by months*

	Dysentery (all)	Diarrhea	Enteritis and colitis	Total
1917				
April	1.76	2.09	17.63	21.48
May	1.76	2.49	17.11	21.36
June	2.41	4.70	23.75	30.86
July	.63	5.44	26.88	32.95
August	.87	6.21	43.36	50.44
September	1.28	6.54	32.05	39.87
October	.72	4.86	17.75	23.33
November	.64	1.04	7.76	9.44
December	.34	.69	6.72	7.75
1918				
January	.36	1.20	6.75	8.31
February	.14	.94	6.77	7.85
March	.50	1.20	9.76	11.46
April	.49	3.98	13.04	17.51
May	.79	5.28	15.62	21.69
June	1.17	9.78	18.70	29.65
July	.91	11.34	19.94	32.19
August	.69	13.66	21.69	36.04
September	.82	8.63	11.74	21.19
October	.29	4.48	6.21	10.98
November	.36	4.67	5.47	10.50
December	.38	2.83	4.31	7.52
1919				
January	.52	2.43	4.32	7.27
February	.38	1.17	4.10	5.65
March	.38	1.59	4.45	6.42
April	.35	2.19	3.85	6.39
May	.74	2.59	4.98	8.31
June	.49	3.06	8.85	12.40
July	.28	4.07	10.88	15.23
August	.23	5.43	14.85	20.51
September	.56	3.54	9.40	13.50
October	.43	5.83	6.52	12.78
November	.54	3.17	7.52	11.23
December	.27	2.04	8.95	11.26
Average, 1917	1.16	3.78	21.45	26.39
Average, 1918	.58	5.67	11.74	17.97
Average, 1919	.46	3.09	7.39	10.94
Average for war	.64	4.89	12.92	18.45

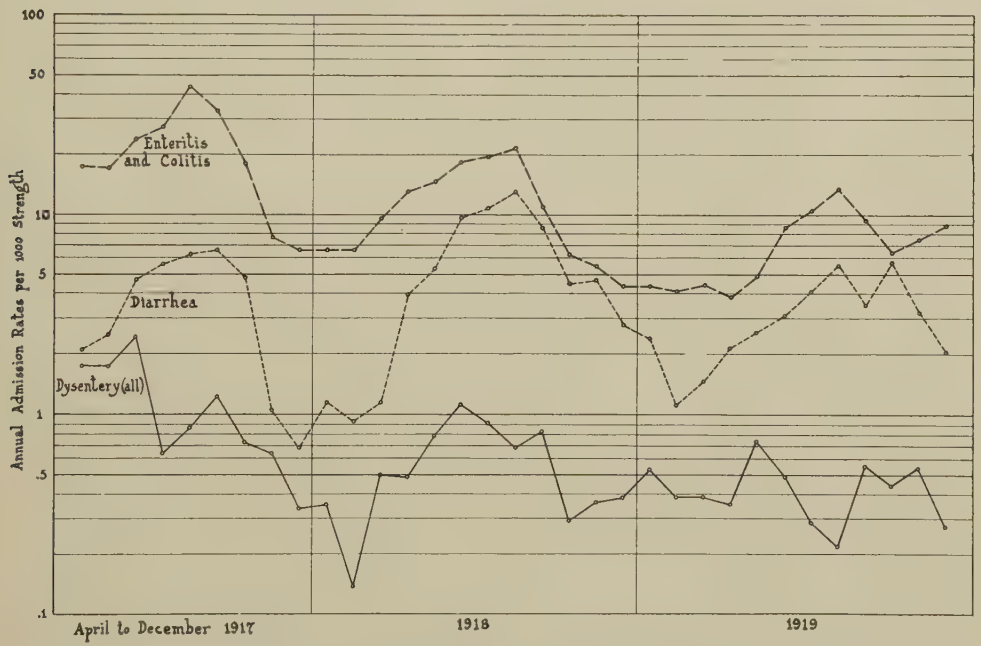

CHART XXXVI.—The diarrheal group of diseases. Annual admission rates by months for dysentery (all), diarrhea, and enterocolitis, white enlisted men in the United States

Study of the figures given in Table 47, and the graphic comparison of the rates shown in Chart XXXVI, which is drawn from the same figures on a logarithmic scale of ordinates, leads to the conclusion that while the rates for cases classed as "diarrhea" and those for "enterocolitis" rose and fell together in almost perfect correlation, the cases classed as "dysentery" varied independently, showing not nearly so much seasonal variation, and the curve for dysen-

tery is quite independent of that for diarrhea or that for enterocolitis. We are thus justified on statistical grounds in assuming that the distinction made by the reporting officers is an entirely valid one. We are further supported in this conclusion by the analysis of the severity of the average case as shown by the number of days lost from duty per case under each heading. Three thousand five hundred and forty-seven cases of dysentery in white enlisted men accounted for the loss of 99,561 days, or 28.3 days per case. There were 19,125 cases classed as "diarrhea," with 215,420 days lost, or 11.2 days per case. Enterocolitis resulted in the loss of 605,811 days among 56,865 cases, the average case losing 11.4 days from duty. It is seen that the two latter conditions were of equal severity, while the dysentery cases averaged much greater severity. It seems amply justifiable, therefore, to divide the consideration of these diseases into two groups, the dysenteries, on the one hand, and the cases reported as "diarrhea" and as "enterocolitis," on the other. Both groups are doubtless of mixed etiology. In the dysentery group we shall find some data for conclusions as to the relative importance of the recognized inciting agents in the period of the war. In the second group no specific statements as to bacterial or protozoal etiology are possible.

Table 47 shows the further interesting fact that the rates for all classes of diarrheal diseases showed a marked tendency to decrease as time passed. The highest rates were shown during the first months of mobilization, during the period of voluntary recruiting, and before the completion of the great training camps and cantonments which housed the National Army during the period of preparation. During the following year, 1918, although the camps were constantly filled with recruits as the older troops were sent to the front, the rates for these diseases showed a definite decline. This may probably be best explained by the improved environmental conditions possible in the completed camps and by the results of training in sanitary matters. However, the rates for 1919 showed a still further improvement. During this year the camps were the scene of the rapid demobilization of the Army. Men returned from abroad and passed rapidly to the camp selected for discharge. Conditions were not as favorable for maintaining a high sanitary standard as was the case in the previous year, though every effort was made to do so. It may be permissible to argue that the low rates during demobilization indicate that in the intestinal infections as in those of the respiratory tract the seasoned soldier shows a greater resistance than does the recruit.

TABLE 48.—*The diarrheal diseases (dysentery, acute and chronic, and diarrhea). Admissions and deaths, absolute numbers and ratios per 1,000 per annum, white enlisted men, United States Army, 1819 to 1919*

Year	Total mean annual strengths	Admissions		Deaths		Year	Total mean annual strengths	Admissions		Deaths	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength			Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
1819 [a]	8,688	2,281	262.54	9	1.04	1870	29,021	9,355	322.35	43	1.48
1820	8,942	3,315	370.72	51	5.70	1871	26,814	7,478	278.88	30	1.12
1821	5,746	2,359	410.55	82	14.27	1872	24,294	6,806	280.15	25	1.03
1822	5,211	1,641	314.91	31	5.95	1873	25,272	6,678	264.25	17	.67
1823	5,949	1,697	285.26	18	3.03	1874	24,371	5,856	240.29	18	.74
1824	5,779	2,197	380.17	6	1.04	1875	21,508	4,809	223.59	10	.46
1825	5,719	1,814	317.19	12	2.10	1876	22,733	5,519	242.77	12	.53
1826	5,809	2,742	472.03	21	3.61	1877	21,642	4,195	193.84	9	.42
1827	5,722	2,337	408.42	18	3.15	1878	21,542	4,814	223.47	13	.60
1828	5,529	1,869	338.04	15	2.71	1879	21,946	4,944	226.31	8	.37
1829	6,169	1,750	283.68	7	1.13	1880	21,566	4,655	215.85	9	.42
1830	5,951	1,828	307.18	7	1.18	1881	20,903	4,591	219.63	6	.29
1831	5,869	2,039	347.42	6	1.02	1882	20,910	4,379	209.42	6	.29
1832 [b]	(c)	(c)	(c)	(c)	(c)	1883	21,064	4,374	207.65	7	.33
1833	(c)	(c)	(c)	(c)	(c)	1884	21,740	3,480	160.07	2	.09
1834	(c)	(c)	(c)	(c)	(c)	1885	21,944	3,433	156.44	6	.27
1835	(c)	(c)	(c)	(c)	(c)	1886	21,430	2,962	138.22	8	.37
1836	(c)	(c)	(c)	(c)	(c)	1887	21,601	2,832	131.11	5	.23
1837	(c)	(c)	(c)	(c)	(c)	1888	22,310	2,448	109.73	3	.13
1838	8,653	6,499	751.07	137	15.83	1889	22,591	2,604	115.27	3	.13
1839	9,704	2,650	273.08	46	4.74	1890	21,910	2,517	114.88		
1840	10,116	4,807	475.19	47	4.65	1891	20,909	2,148	102.73	2	.10
1841	9,748	6,699	687.22	137	14.05	1892	21,437	2,373	110.70		
1842	10,000	5,759	575.90	110	11.00	1893	22,429	2,251	100.36	1	.04
1843	9,863	3,358	340.46	27	2.74	1894	22,904	2,174	94.91	3	.13
1844	8,570	2,260	263.71	10	1.17	1895	23,195	1,948	93.98	1	.04
1845	8,590	3,046	354.60	8	.93	1896	23,014	1,833	79.64		
1846	9,083	6,351	699.22	63	6.94	1897	23,253	1,693	72.80		
1847 [d]	(c)	(c)	(c)	(c)	(c)	1898 [f g]	140,395	56,192	400.24	202	1.44
1848	(c)	(c)	(c)	(c)	(c)	1899 [g]	98,635	39,040	395.79	222	2.25
1849	9,148	7,905	864.12	180	19.67	1900 [h]	92,374	44,608	482.91	629	6.81
1850	8,970	4,828	538.24	64	7.13	1901 [h]	85,357	24,846	291.08	276	3.23
1851	9,242	4,047	437.89	60	6.49	1902 [h]	71,679	20,370	284.19	171	2.39
1852	9,203	4,337	471.26	53	5.76	1903	59,671	9,625	161.30	50	.84
1853	9,904	3,892	392.97	47	4.75	1904 [i]	55,619	5,722	102.89	15	.27
1854	8,095	3,381	417.67	23	2.84	1905	53,573	4,218	78.74	12	.22
1855	9,367	5,452	582.04	33	3.52	1906	53,249	4,719	88.62	5	.09
1856	14,434	8,655	599.62	74	5.13	1907	50,705	2,613	51.54	2	.04
1857	12,701	5,754	453.03	20	2.05	1908	62,263	3,063	49.20	6	.10
1858	14,510	6,052	417.09	22	1.52	1909 [f]	71,025	2,433	34.26	13	.18
1859	15,510	4,619	297.81	12	.77	1910	68,548	2,196	32.04	5	.07
1860	13,531	3,707	273.96	18	1.33	1911	69,746	1,567	22.47		
1861	19,954	13,702	686.68	16	.80	1912	74,366	1,021	13.73	2	.03
1862	279,371	215,058	769.79	[e] 1,205	4.17	1913	76,135	750	9.85	7	.09
1863	614,325	521,879	849.52	[e] 10,554	15.99	1914	81,750	668	8.17	4	.05
1864	619,703	395,720	638.56	[e] 10,661	15.78	1915	87,458	547	6.26	2	.02
1865	574,022	393,783	686.01	[e] 13,740	21.29	1916 [j]	159,553	13,956	87.47	16	.10
1866	99,080	48,984	494.40	[e] 1,630	16.00	1917 [k]	594,005	2,963	4.77	4	.01
1867	40,183	22,942	570.94	172	4.28	1918 [k]	2,207,631	17,763	8.05	53	.02
1868	42,861	16,795	391.85	75	1.75	1919 [k]	843,451	2,301	2.73	12	.01
1869	31,376	9,320	297.04	33	1.05						

[a] For years 1819–1848, inclusive, statistics are for the year ending Sept. 30, for the years 1849–1882, inclusive, year ending June 30; for the years 1883–1919, inclusive, year ending Dec. 31.
[b] Cholera epidemic, Black Hawk War.
[c] No strength records available for these years.
[d] Covers period of Mexican War (1847–48).
[e] Civil War period: Ratios per 1,000 per annum for deaths, based on following strengths: 1862, 288,919; 1863, 659,955; 1864, 675,412; 1865, 645,506; 1866, 101,897; 1867, 40,183.
[f] Years 1898–1903, inclusive, covers period of Spanish-American War and Philippine insurrection; also covers period; of the China expedition. (1900–01).
[g] These two years (1898–99) not tabulated separately; does not inclue enteritis.
[h] Reported as "other diarrheal diseases," but does not include dysentery and enteritis.
[i] Previous to this year, officers were included with white enlisted men; beginning 1904 they are excluded.
[j] 1916 includes enteritis.
[k] Covers period of World War, through period of demobilization.

Table 48 and Chart XXXVII, drawn from the same figures on a logarithmic scale of ordinates, show the experience of the United States Army with diarrheal diseases for the 100-year period 1819–1919. Inasmuch as in the earlier years there were no colored enlisted men in the Army, the figures are for white enlisted men throughout. The rates are the total of dysentery, diarrhea, enteritis, and colitis, since for the reasons given no accurate differentiation of these diseases is possible during this period. While there are periods for which no figures are available it is evident that there has been a definite downward trend in the rates for admissions and deaths from these diseases broken only by wars and mobilizations. The figures for the Mexican War period are missing, but reports indicate that the rates for diarrhea and dysentery were excessively high at that time. The additional conclusion

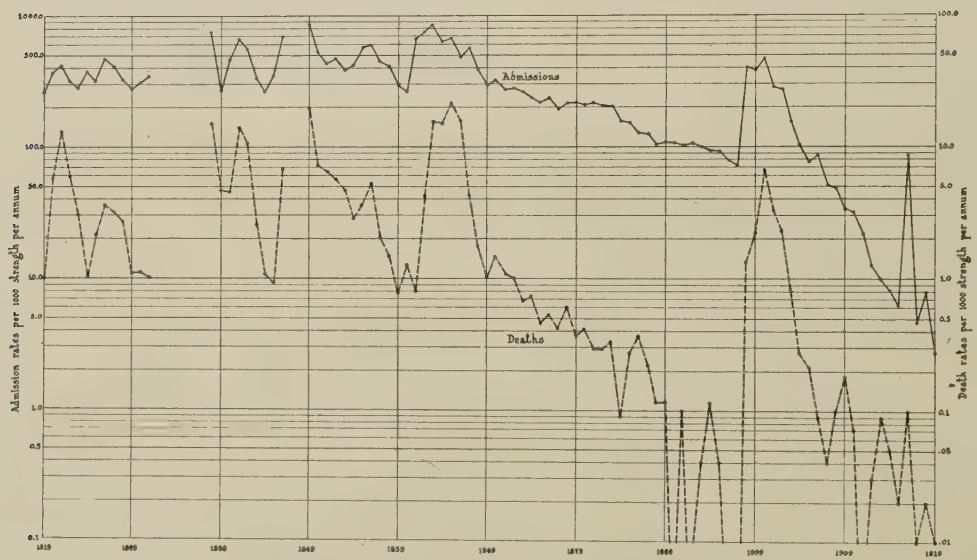

CHART XXXVII.—The diarrheal group of diseases. Admissions and deaths in the United States Army, 1819 to 1919. Annual rates per 1,000 strength

from these figures is that during the century each war showed a decreasingly great increase in the incidence of the diarrheas over the preceding peace-time figures. This tendency culminated in the World War, during which the rates for the combined diarrheal diseases were actually lower than at any previous time in the history of our Army.

Some details of this record will be considered later and further comparisons made. Here it will suffice to point out that while in the record of the Civil War a large volume was required for the consideration of these diseases, here they occupy but insignificant space. In the Spanish-American War and Philippine insurrection, the dysenteries and diarrheas formed a formidable proportion of the total illnesses afflicting the troops. It should be remembered in this connection, however, that these campaigns were conducted in tropical countries and the special liability to intestinal disease of troops serving

in the Tropics has long been recognized. Doubtless some of the freedom from these diseases enjoyed by the Army in the World War was the result of the geographical location of the territory occupied, but making all allowance for this factor it becomes evident that the disparity in rates for diarrheal diseases between the World War and those preceding it must be mainly due to improved methods and practices of sanitation.

TABLE 49.—*Dysentery (all), diarrhea, and enterocolitis. Officers and enlisted men, United States Army, by countries of occurrence. Primary admissions, deaths, discharges for disability, and noneffectiveness, absolute numbers and ratios per 1,000 per annum, April, 1917, to December, 1919*

	Total mean annual strengths	Dysentery (all)								Diarrhea							
		Primary admissions		Deaths		Discharges for disability		Noneffectiveness		Primary admissions		Deaths		Discharges for disability		Noneffectiveness	
		Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Days lost	Noneffective ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Days lost	Noneffective ratios per 1,000
Total officers and enlisted men, including native troops	4,128,479	4,738	1.15	73	0.02	86	0.02	128,223	0.09	22,433	5.43	21	0.01	13		245,748	0.16
Total officers and enlisted men, American troops	4,092,457	4,546	1.11	69	.02	85	.02	125,693	.08	22,215	5.41	21	.01	13		244,784	.16
Total officers	206,382	254	1.23	1		3	.01	8,927	.12	847	4.10					6,360	.08
Enlisted American troops:																	
White	3,599,527	3,547	.99	54	.02	79	.02	99,561	.08	19,125	5.31	18	.01	12		215,420	.16
Colored	286,548	220	.77	8	.03	2	.01	6,248	.06	693	2.42			1		6,411	.06
Color not stated		525		6		1		10,957		1,550		3				16,593	
Total	3,886,075	4,292	1.10	68	.02	82	.02	116,766	.08	21,368	5.50	21	.01	13		238,424	.17
Total native troops (enlisted)	36,022	192	5.33	4	.11	1	.03	2,530	.19	218	6.05					964	.07
U. S. Army in the United States, including Alaska:																	
Officers	124,266	107	.86	1	.01	3	.02	4,421	.10	467	3.76					2,082	.05
White enlisted men	1,965,297	1,261	.64	14	.01	70	.04	31,062	.04	9,604	4.89	1		10	.01	32,327	.05
Colored enlisted men	145,826	131	.90	6	.04	1	.01	3,313	.06	410	2.81			1	.01	2,380	.04
Total enlisted men	2,111,123	1,392	.66	20	.01	71	.03	34,375	.04	10,014	4.74	1		11		34,707	.05
Total officers and men	2,235,389	1,499	.67	21	.01	74	.03	38,796	.05	10,481	4.69	1		11		36,789	.05
U. S. Army in Europe, excluding Russia.																	
Officers	73,728	133	1.80					4,245	.16	315	4.27					4,079	.15
White enlisted men	1,469,556	1,975	1.34	35	.02	8	.01	61,146	.11	8,921	6.07	16	.01	2		178,942	.33
Colored enlisted men	122,412	69	.56	2	.02	1	.01	2,196	.05	231	1.89					3,916	.09
Enlisted men, color not stated		482		6		1		10,688		1,466		3				16,213	
Total enlisted men	1,592,068	2,526	1.59	43	.03	10	.01	74,030	.13	10,618	6.67	19	.01	2		199,071	.34
Total officers and men	1,665,796	2,659	1.60	43	.03	10	.01	78,275	.13	10,933	6.56	19	.01	2		203,150	.33

U. S. Army in the Philippine Islands:																	
White enlisted men	16,995	152	8.94	4	.24	1	.06	4,090	.66	52	3.06					231	.04
Colored enlisted men	4,456	13	2.92					607	.37	39	8.75					88	.05
Total	21,451	165	7.69	4	.19	1	.05	4,697	.60	91	4.24					319	.04
U. S. Army in Hawaii:																	
White enlisted men	16,161	4	.25					112	.02	25	1.55	1	.06			258	.04
Colored enlisted men	3,319									3	.90					6	
Total enlisted men	19,480	4	.21					112	.02	28	1.44	1	.05			264	.04
U. S. Army in Panama: White enlisted men	19,688	28	1.42					719	.10	35	1.78					178	.02
Native troops, enlisted:																	
Philippine Scouts	18,576	111	5.98	3	.16			1,857	.27	92	4.95					465	.07
Hawaiians	5,615	1	.18					8		20	3.56					146	.07
Porto Ricans	11,831	80	6.76	1	.08	1	.08	665	.15	106	8.96					353	.08

TABLE 49.—*Dysentery (all), diarrhea, and enterocolitis. Officers and enlisted men, United States Army, by countries of occurrence. Primary admissions, deaths, discharges for disability, and noneffectiveness, absolute numbers and ratios per 1,000 per annum, April, 1917, to December, 1919*—Continued

	Enterocolitis								Total							
	Primary admissions		Deaths		Discharges for disability		Noneffectiveness		Primary admissions		Deaths		Discharges for disability		Noneffectiveness	
	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Days lost	Noneffective ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Days lost	Noneffective ratios per 1,000
Total officers and enlisted men, including native troops	65,341	15.83	174	0.04	144	0.03	687,258	0.46	92,512	22.41	267	0.07	243	0.05	1,061,229	0.71
Total officers and enlisted men, American troops	64,950	15.87	173	.04	144	.04	684,194	.46	91,711	22.39	263	.07	242	.06	1,054,671	.70
Total officers	3,236	15.68	2	.01	9	.04	37,833	.50	4,337	21.01	3	.01	12	.05	53,120	.70
Enlisted American troops:																
White	56,865	15.80	150	.04	130	.04	605,811	.46	79,537	22.10	222	.07	221	.06	920,792	.70
Colored	2,534	8.84	12	.04	4	.01	24,309	.23	3,447	12.03	20	.07	7	.02	36,968	.35
Color not stated	2,315	------	9	------	1	------	16,241	------	4,390	------	18	------	2	------	43,791	------
Total	61,714	15.88	171	.04	135	.03	646,361	.46	87,374	22.48	260	.07	230	.05	1,001,551	.71
Total native troops (enlisted)	391	10.85	1	.03	------	------	2,064	.16	801	22.23	5	.14	1	.03	5,558	.42
U. S. Army in the United States, including Alaska:																
Officers	1,602	12.88	1	.01	8	.06	10,470	.23	2,176	17.50	2	.02	11	.08	16,973	.38
White enlisted men	25,383	12.92	21	.01	101	.05	138,913	.19	26,248	18.45	36	.02	181	.10	202,302	.27
Colored enlisted men	889	6.09	3	.02	4	.03	7,273	.14	1,430	9.80	9	.06	6	.05	12,966	.24
Total enlisted men	26,272	12.44	24	.01	105	.05	146,186	.19	37,678	17.84	45	.02	187	.08	215,268	.28
Total officers and men	27,874	12.47	25	.01	113	.05	156,656	.19	39,854	17.83	47	.02	198	.08	232,241	.29
U. S. Army in Europe, excluding Russia:																
Officers	1,550	21.02	1	.01	1	.01	26,769	1.00	1,998	27.09	1	.01	1	.01	35,093	1.31
White enlisted men	29,345	19.97	127	.09	27	.02	454,240	.85	40,241	27.38	178	.12	37	.03	694,328	1.29
Colored enlisted men	1,439	11.76	9	.07	------	------	15,508	.35	1,739	14.21	11	.09	1	.01	21,620	.49
Enlisted men, color not stated	2,276	------	9	------	1	------	16,830	------	4,224	------	18	------	2	------	42,931	------
Total enlisted men	33,060	20.77	145	.09	28	.02	485,778	.84	46,204	29.3	207	.13	40	.03	758,879	1.31
Total officers and men	34,610	20.78	146	.09	29	.02	512,547	.84	48,202	28.94	208	.13	41	.03	793,972	1.30
U. S. Army in the Philippine Islands:																
White enlisted men	633	37.25	------	------	------	------	4,420	.71	837	49.25	4	.24	1	.06	8,741	1.41
Colored enlisted men	118	26.48	------	------	------	------	583	.36	170	38.15	------	------	------	------	1,278	.78
Total	751	35.01	------	------	------	------	5,003	.64	1,007	46.94	4	.19	1	.05	10,019	1.28

U. S. Army in Hawaii:																
White enlisted men	269	16.64				1,119	.19	298	18.44	1	.06			1,489	.25
Colored enlisted men	38	11.45				121	.10	41	12.35					127	.10
Total enlisted men	307	15.76				1,240	.17	339	20.80	1	.05			1,616	.23
U. S. Army in Panama: White enlisted men	127	6.45				782	.11	190	9.65					1,679	.21
Native troops, enlisted:															
Philippine Scouts	179	9.64				1,020	.15	382	20.57	3	.16			3,342	.49
Hawaiians	3	.53				10		24	4.27					164	.07
Porto Ricans	209	17.66	1	.08		1,034	.24	395	33.38	2	.16	1	.08	2,052	.47

OCCURRENCE IN THE WORLD WAR

A general view of the occurrence of the diarrheal group of diseases during the World War is given in Table 49. The figures are not only for the Army as a whole but also for those fractions stationed in the principal geographical locations occupied by our troops. The cases are grouped under four headings, "Dysentery (all)," which includes the unclassified cases as well as those etiologically diagnosed, "Diarrhea," and "Enterocolitis," the latter including cases reported as either enteritis or colitis. The fourth heading gives the total of the three named, thus representing for the World War period a close approximation to the totals given for the preceding century in Table 48. The absolute numbers under each heading are for the period of the war. The corresponding rates per thousand are based on a strength aggregate obtained by the summation of the mean strength for each year, the resulting rate being an annual rate per thousand strength. In the case of the noneffective rate the annual figure is further divided by 365 to give a rate directly comparable to the usual average noneffective rate of Army reports, which represents the number of men per thousand constantly excused from duty for any given cause.

Of the total of 92,512 admissions only 4,738 were reported as dysentery cases, or 5.12 per cent of the group. It is probable, owing to the policy of the Surgeon General already referred to, of requiring an etiological diagnosis in reports of cases of dysentery whenever facilities for such work are available, that a certain proportion of cases of dysentery were reported under the other headings as diarrhea, or more probably as enteritis or colitis. However, a most liberal estimate of such cases could not more than double the probable number of dysentery cases and that would mean that but 10 per cent of the diarrheal group of diseases were dysentery. In the Philippines and in Panama that proportion was exceeded, but there is no reason for extending the effect of tropical environment to the mass of the Army. It would appear, then, that a striking fact in the figures before us is that the proportion of cases of the serious or fatal type, true dysentery, was small compared to the total of the group. That the total incidence, while impressive in absolute numbers of cases, was not of serious import in loss of man power, is shown by the annual admission rate of 22.41 per annum, which, distributed over a year, would mean a little less than two cases per month for each thousand men. As the greater number of these admissions were for the milder types of intestinal disturbance, the total number of days lost from duty on account of diseases of this group amounted to only 1,061,229, a figure that gives a noneffective rate for the period of 0.71, which means that on the average 1 man in a little over 1,400 was excused from duty on account of one of these conditions.

The loss to the Army by deaths due to this group totaled 267, with an annual rate per thousand of 0.07, or 1 death per year in each 14,282 men. An even smaller number of men were lost to the service by discharge for disability, namely, 243, which gives a rate of 0.05 per thousand per annum, or 1 each year to 20,000 men.

As a measure of the progress made in military sanitation in the last half century it is instructive to compare the record given above with that of the Civil War. There were during that conflict 1,585,196 cases of diarrhea and dysentery

in an average strength of 2,193,427 white troops.[1] Had the same rate prevailed in the World War there would have been 2,601,915 cases among white troops. Had the incidence rate for colored troops in the Civil War obtained in the World War there would likewise have been 240,517 cases among our colored soldiers, a total of 2,842, 432. As a matter of fact there were reported as diarrhea and dysentery during the World War but 27,171 cases, or less than 1 per cent of the number that would have obtained had Civil War conditions been repeated. If we include the enterocolitis cases reported during the World War the total, already given, is 92,512, or, roughly, 3 per cent of the cases to have been expected at Civil War rates.

In the Civil War there were 37,794 deaths among white troops and 6,764 among colored troops charged to dysentery and diarrhea. At these rates there would have been 62,021 deaths among white soldiers and 10,427 among the colored in the recent war, a total of 72,448. The total deaths ascribed to this group of diseases in 1917–1919 was only 267, a saving of 72,181 lives. It is perhaps claiming too much to attribute this impressive difference entirely to advances in sanitation and therapeutics, as other factors such as differences in the geographical location of the campaigns, questions of the nomenclature and classification of disease, may have entered into the comparison; but however explained, the impressive fact remains that this enormous saving of life and disability has been accomplished not only in this group of diseases but in the related typhoid-paratyphoid group as well. Instead of being the most important cause of illness and death in the Army, the diarrheal group ranked seventh among diseases for admissions, tenth for deaths, and twelfth for days lost from duty. That, nevertheless, these diseases are an ever-present menace to armies, and that military concentrations, especially under active service conditions, still present dangers from intestinal infections is shown by Table 50, which compares the death rates obtaining in the Army during the World War with those of the comparable age and sex groups in the United States registration area for the same period. It is seen that the Army rate for dysentery is ten times that of the civilians, for diarrhea and enteritis seven times, and for the group as a whole a little more than seven times as great.

TABLE 50.—*Diarrheal group of diseases. Comparative mortality in the United States Army during the World War, and the United States registration area, males, age 20–34, 1917–1919. Annual death rates per 1,000*

	Registration area,[a] males, 20–34	U. S. Army[b]
Dysentery	0.002	0.02
Diarrhea and enteritis	.007	.05
Total	.009	.07

[a] Compiled from Mortality Statistics, Bureau of the Census, 1917–1919.
[b] Reports of sick and wounded, S. G. O. 1917–1919.

Certain other facts are brought out by Table 49 which are worthy of more than passing notice. The admission rates for the group were approximately the same for officers and men whether stationed in the United States or in Europe. The same is true of the death rates for those stationed in the United States.

In Europe, however, the death rate for the group is much higher for enlisted men than for officers. This fact will be referred to again in the discussion of dysentery. In general, the rates for admissions and deaths in this group are much higher in Europe than is the case with troops in the training camps at home. That this was due to the stress of battle conditions is evident from the monthly rates for the diseases in question, which show that great military activity was always accompanied by an increase in the incidence of diarrhea.

The prevalence of diarrheal disease in our Army in Europe was undoubtedly greater than the figures of Table 49 would indicate. Many of the cases were of a mild type and as such were not made a matter of record. Moreover, early in the war only hospital admissions were recorded in Europe. The following quotation gives an idea of the general prevalence of the diarrheal diseases during the summer of 1918 in the American Expeditionary Forces.[2]

Epidemic diarrheas, with a considerable amount of dysentery and probably some unrecognized typhoid and paratyphoid fevers, developed in various parts of France late in June, appearing first in the more southern areas occupied by our troops, and wherever insanitary disposal of human wastes, fly breeding, and insufficient precautions in the preparation and serving of food prevailed. Immediately after the Chateau Thierry operation the troops suffered quite generally from diarrheal diseases, probably as many as 70 per cent having been so affected. This was inevitable under the conditions of a hard-fought and prolonged battle which made even the elementary principles of sanitation impracticable of application. Inadequate and ill-prepared food, chilling of the body at night, polluted water sources, and the plague of flies, which bred and fed upon human excreta everywhere exposed and upon the dead bodies of men and draft animals upon the battle fields, combined to produced a widespread epidemic of diarrhea among which was a certain proportion of true dysentery and typhoid-paratyphoid infections. Most of the cases never reached a hospital or obtained medical treatment. Spontaneous recovery in a few days was the rule. The enthusiasm of the victorious forward movement of the troops carried many men out of reach of hospitalization, and a true measure of noneffectiveness from that epidemic can only be guessed. A small number of serious and persistent infections found their way through the evacuation hospitals to the base hospitals, and of these the great majority examined early in the course of their disease were found to be suffering from true dysentery caused by well-known strains of bacilli. Fortunately the type of the infection was mild and very few deaths resulted from the entire epidemic. The disease prevailed during the warm weather while the fly-breeding season continued. In a few favored places, where medical care was combined with adequate physical equipment to avoid fecal exposure and pollution of food and water, only an occasional case of diarrhea developed and entire organizations escaped infection, but in the main the disease prevailed throughout the American Expeditionary Forces from July to the middle of September.

That these diseases continued through the fall of 1918, during the Meuse-Argonne operation and immediately thereafter, is shown in the following report of the surgeon of the Second Army.[3]

The movements of the 79th Division troops during October and November took them into the region formerly occupied by German troops around Etraye, Reville, Crepion, Gibercy, and Damvillers, where the Germans had a hospital with considerable intestinal disease, some of their latrines being reserved for "intestinal cases." Previous to this the troops, while in action in November, drank water from shell holes, springs, and wells. Diarrhea developed so that estimates of regimental medical officers ranged from 50 to 75 per cent of the command.

A mobile laboratory investigated the outbreak in the 79th Division and from the report it appears that there were cases reported as diarrhea which in reality were typhoid fever. The investigation also extended to the 7th Division, where a great many soldiers were examined for the typhoid carrier state. Of 100 kitchen personnel examined, 25 per cent gave a history of having had "bowel trouble."

A report from Base Hospital No. 89 shows the difficulty of classifying the diseases generally listed as "diarrhea."[4]

> The cases of infectious diarrhea, which come to the hospital by the score, were nearly always in soldiers who had been ill for many days. The stools of practically every case were examined bacteriologically, but we were never able to find amebæ or the organisms of bacillary dysentery, although we all felt sure that the latter was the cause of the symptoms present. Numerous organisms resembling the bacillary types were isolated, but none of them agglutinated with known sera.

Of the relatively small bodies of our troops stationed in various parts of the world other than the United States and Europe, some were in tropical countries and such generally suffered more severely from the diarrheal diseases, especially from true dysentery. By far the highest admission and death rates for the diarrheal group in white enlisted men in the Army was shown by the force of about 17,000 men stationed in the Philippine Islands. The admission rates in Panama were not notably above the average for the group, though there was a disproportionately large incidence of a nonfatal form of dysentery. The incidence in Hawaii was about the same as that in the United States.

An interesting racial difference appears when the rates for white and colored troops are compared. Almost without exception admission rates in these diseases are definitely higher for the white soldier, sometimes several times as high. On the other hand, the greater fatality of the individual case in the negro brings his death rate up to or higher than that of the white. From the standpoint of noneffectiveness, the negro shows to excellent advantage, as his noneffective rate for the diarrheas is definitely less than that of the white.

The native Porto Rican and native Filipino soldiers, also of races indigenous to the Tropics, manifest no such advantage. After the whites in the Philippines, these groups showed the highest susceptibility to diarrheal diseases. It is perhaps possible that the colored American soldier benefited from the effects of discipline and sanitary training. The colored troops in the Tropics were in organizations of long service.

There were considerable differences in the rates of different training camps in the United States. In general the camps showing higher rates were more apt to be located in the Southern States than were camps showing low rates. The camps showing the highest annual admission rates were Camp Hancock, Ga. (27.21); Camp Beauregard, La. (26.91); Camp MacArthur, Tex. (26.51); and Camp Doniphan, Okla. (27.70). The lowest rates for admissions were Camp Forrest, Ga. (4.34); Camp Eustis, Va. (6.93); and Camp Fremont, Calif., (4.48).

THE DYSENTERIES

OCCURRENCE

In the discussion of the prevalence of true dysentery during the World War it is not permissible to rely exclusively on the records. Statistical tables are not always to be regarded as complete in themselves, nor are the various figures of which they are composed to be regarded as conveying always entirely truthful impressions, unless they are interpreted with some knowledge of the sources of the information which entered into their compilation, and of the difficulties which beset those making the original reports. Several of the difficulties which serve to render the recorded figures for the dysenteries an understatement of the actual facts have been brought out in the previous pages. The clinical characters of mild dysentery are so similar to those of a nonspecific enterocolitis that some confusion is to be expected in the reports of these conditions. It has already been pointed out that the number of days lost per case in dysentery as reported was much greater than was the cases in the nonspecific diarrheas. One is justified, therefore, in assuming that, as a class, the cases reported as diarrhea and as enteritis or colitis were different from and milder than the cases of dysentery. That some cases of dysentery were included in the epidemics of intestinal disease experienced by the troops at the front during periods of great military activity has been indicated by several reports quoted above. Also that an undetermined but probably large number of these cases escaped hospitalization entirely and were probably never reported at all. Of those which did reach hospitals and were reported as cases of diarrhea or enterocolitis, it is probable that many were true dysentery, although no specific diagnosis could be made. This was the opinion expressed in the report from Base Hospital No. 98 already quoted.

If a considerable proportion of the more severe dysentery cases were included under the headings "diarrhea" and "enterocolitis" it would serve to increase the average severity of the latter cases and increase the number of days lost per case, and also the case fatality. Of the 9,604 cases of diarrhea reported in white enlisted men in the United States (Table 49), only one proved fatal, a fatality of slightly over one one-hundredth of one per cent. The average duration of these cases was three and three-tenths days. Of the 8,921 cases reported from Europe, 16 were fatal, 0.18 per cent, and the average of the days lost was 20. The corresponding figures for enterocolitis in the United States were, case fatality 0.082 per cent with 5.5 days lost per case, and in Europe, fatality 0.43 per cent and 14.7 days lost per case. It is evident that some element was present in the European cases which greatly increased the severity of the average. That this was the inclusion under these headings of a certain number of cases of true dysentery is probable for all of the reasons given. An exact estimate of the number of cases so included is manifestly impossible, but judging from the excess number of deaths per thousand cases in Europe over the corresponding figures from the United States, and applying to these deaths the case fatality of the reported dysentery cases, it seems possible that the true incidence of dysentery was not far from

double that shown in the tables. This conclusion does not in any way vitiate the comparison already given between recent rates and those of the Civil War, as that comparison was based on totals of the entire group and not on dysenteries alone.

ETIOLOGIC TYPES

Here again in order to properly evaluate the figures given it is necessary to appreciate certain facts in regard to the difficulties in the specific diagnosis of a given case of dysentery. The isolation of the specific dysentery bacilli from the stool of a patient depends for its success upon a combination of circumstances not easily attained under war conditions, indeed not always possible of attainment under most favorable surroundings. After the possession of adequate facilities the most important of these conditions are that the stool should have been recently passed, and that the patient should have been in the very early stages of his disease. The latter requirement is probably explained by the early development in the intestines of the bacteriophage of d'Hérelle, which inhibits growth of the specific organism. Under war conditions, therefore, when adequate laboratories were not always available, when stools were often necessarily delayed on the way to the laboratory, and when the majority of patients had been ill for several days before reaching a hospital at which bacteriological work could be initiated, it should be expected that many, probably a majority, of the cases of true bacillary dysentery should fail of bacteriological confirmation.

In a way the reverse is true of entamebic cases. It is coming to be more and more generally recognized that finding *E. histolytica* in the stool does not constitute valid grounds for the diagnosis of amebic dysentery. Of all individuals who harbor the entameba in their intestines, only a small proportion, probably not over 3 per cent, ever develop dysenteric symptoms. The others remain healthy carriers as evidenced by the more or less constant evacuation of the cysts of the organism. When such a carrier becomes affected with any diarrheal disease, the trophozoites or active vegetative forms of the organism are carried down and evacuated, and their discovery may lead to a diagnosis of amebic dysentery not justified by the facts. As will be shown later, a considerable proportion of our troops returned from France carrying this organism in their intestines. It seems probable that a certain percentage of cases on record as amebic dysentery were probably of bacillary origin in carriers of the entameba. Two circumstances fortify this conclusion. First, the entameba is readily identified under the microscope, especially as compared with the difficult and time-consuming process of isolation of the dysentery bacilli. Secondly, the cytologic methods by which it is now possible to distinguish with great accuracy between the two main types of dysentery had not at the time of the World War been perfected, but since, in the hands of Willmore and Shearman,[5] Manson-Bahr,[6] and Haughwout,[7] have attained great reliability.

All these considerations lead to the conviction that the number of cases of bacillary dysentery were understated in the records, that that of the amebic cases was overstated, and that the majority of the cases reported as dysentery unclassified were probably in reality of the bacillary type. This was undoubtedly especially true in Europe where the dysentery cases occurred in

epidemic groups since, owing to the biological peculiarities of the organism, amebic dysentery is rarely known to occur in epidemic outbreaks.

Tables 51 and 52 show the incidence of the various types of dysentery in white enlisted men by months in the United States and in Europe. In Europe bacillary and amebic dysentery and the unclassified group as well, varied in a closely correlated manner. This would hardly be expected in two conditions epidemiologically so different as bacillary and amebic dysentery. In the United States, where there were no epidemic outbreaks of the disease, but only the slower seasonal variations, it is possible to compare the curve of the unclassified

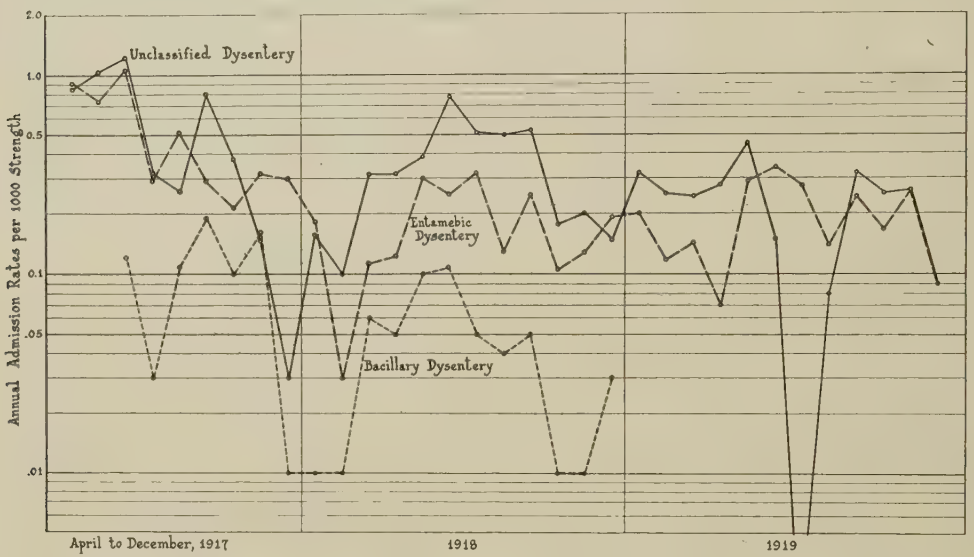

CHART XXXVIII.—Dysentery, incidence by etiologic types by months, annual rates per 1,000, white enlisted men, United States Army, in the United States

group with those of the bacillary and amebic cases in the attempt to see which pair are the more closely correlated. The curves are shown in Chart XXXVIII. That for bacillary dysentery ends with 1918, as but one case of this disease was reported during 1919. It is seen that the curve for bacillary dysentery more closely approximates that of the unclassified dysenteries than does the curve for amebic cases. The number of cases classified each month was so small that the comparison loses some of its value, but for as much as it is worth it bears out the conclusion already arrived at that the great majority of the cases reported in the tables as "dysentery unclassified" were in fact bacillary cases.

TABLE 51.—*Dysentery. Incidence by types, and annual ratios per 1,000 by months, white enlisted men, United States Army, in the United States, April, 1917, to December, 1919*

	Strength	Bacillary		Balantidic		Entamœbic		Other protozoal		Unclassified		Total	
		Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000
1917													
April	183,758	0				14	0.91			13	0.85	27	1.76
May	245,454	0				15	.73			21	1.03	36	1.76
June	309,205	3	0.12			28	1.09			31	1.20	62	2.41
July	458,817	1	.03			11	.29			12	.31	24	.63
August	562,714	5	.11			24	.51			12	.26	41	.87
September	776,466	12	.19			19	.29			52	.80	83	1.28
October	1,032,244	9	.10			19	.22	1	0.01	33	.38	62	.72
November	1,061,422	14	.16			28	.32	2	.02	13	.15	57	.64
December	1,129,065	1	.01			28	.30			3	.03	32	.34
1918													
January	1,096,434	1	.01	1	0.01	16	.18			15	.16	33	.36
February	1,095,039	1	.01			3	.03			9	.10	13	.14
March	1,129,223	6	.06			11	.12	1	.01	29	.31	47	.50
April	1,168,558	5	.05			13	.13			30	.31	48	.49
May	1,197,757	10	.10			30	.30			39	.39	79	.79
June	1,303,746	12	.11			27	.25	2	.02	86	.79	127	1.17
July	1,328,513	6	.05			35	.32	4	.04	56	.51	101	.91
August	1,284,247	4	.04			15	.14	2	.02	53	.50	74	.69
September	1,321,440	5	.05			27	.25	1	.01	57	.52	90	.82
October	1,343,933	1	.01			12	.11	1	.01	19	.17	33	.29
November	1,255,195	1	.01			15	.14	1	.01	21	.20	38	.36
December	941,219	2	.03			15	.19	1	.01	12	.15	30	.38
1919													
January	672,937	0				11	.20			18	.32	29	.52
February	471,815	0				5	.13			10	.25	15	.38
March	406,839	0				5	.15			8	.24	13	.38
April	339,836	0				2	.07			8	.28	10	.35
May	291,810	0				7	.29			11	.45	18	.74
June	246,903	0				7	.34			3	.15	10	.49
July	215,104	0				5	.28			0		5	.28
August	156,791	0				2	.15			1	.08	3	.23
September	149,360	0				3	.24			4	.32	7	.56
October	139,877	0				2	.17			3	.26	5	.43
November	132,403	0				3	.27			3	.27	6	.54
December	135,441	1	.09			1	.09			1	.09	3	.27
Total	1,965,297	100	.05	1	0	458	.23	16	.01	686	.35	1,261	.64

TABLE 52.—*Dysentery. Incidence by types, and annual ratios per 1,000 by months, white enlisted men, United States Army, in Europe, April, 1917, to December, 1919*

	Strength	Bacillary		Balantidic		Entamœbic		Other protozoal		Unclassified		Total	
		Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000	Absolute numbers	Annual ratios per 1,000
1917													
April													
May	13,420	1	0.89							1	0.89	2	1.79
June													
July	28,821	2	.83			1	0.42			4	1.67	7	2.91
August	50,882									1	.24	1	.24
September	70,266					1	.17			2	.34	3	.51
October	92,139					3	.39			2	.26	5	.65
November	123,429					3	.20			7	.68	10	.97
December	160,178					2	.15	1	0.07	9	.67	12	.90
1918													
January	193,264	3	.19			1	.06			5	.31	9	.56
February	223,130	1	.05			0				2	.11	3	.16
March	283,268	2	.08			3	.13			3	.13	8	.34
April	388,048	0						1	.03	5	.16	6	.19
May	587,240	1	.02			3	.06	0		5	.10	9	.18
June	796,427	1	.02			2	.02	0		7	.11	10	.15
July	1,063,192	55	.62	3	0.03	8	.09	2	.02	53	.60	121	1.37
August	1,266,592	67	.63	1	.01	21	.20	2	.02	275	2.61	366	3.47
September	1,527,793	34	.27			25	.20	2	.02	314	2.47	375	2.95
October	1,635,321	38	.28			11	.08	4	.03	493	3.64	546	4.01
November	1,682,836	9	.06			13	.09	0		239	1.70	261	1.86
December	1,591,962	5	.04			6	.05	1	.01	91	.69	103	.78
1919													
January	1,488,683	3	.02			6	.05			26	.21	35	.28
February	1,310,083	1	.01			5	.05			22	.20	28	.26
March	1,115,693	0				1	.01			2	.02	3	.03
April	853,425	0				5	.07			3	.04	8	.11
May	569,842	0				0				0		0	
June	271,633	0				0				5	.22	5	.22
July	111,634	4	.43			1	.11			4	.43	9	.97
August	48,006	15	3.75			1	.25			6	1.50	22	5.50
September	30,315	0				2	.79			1	.40	3	1.19
October	21,055	1	.57			1	.57			0		2	1.14
November	18,920	0				0				0		0	
December	18,379	0				0				0		0	
Not stated										3		3	
Total	1,469,656	243	.17	4	0	125	.09			1,590	1.08	1,975	1.34

Seventy per cent of the dysentery cases were reported without etiologic classification (Table 53), 47 per cent in 1917, 78 per cent in 1918, and 52 per cent in 1919. The proportion so reported varied greatly from month to month, usually highest when the absolute number of cases was greatest especially in the European cases. Of the classified cases, those reported as amebic consistently exceeded those called bacillary. During the World War (Table 53) there were reported 926 amebic cases to 460 demonstrated as bacillary, a proportion of nearly 2 to 1. Inasmuch as, combined, these two groups represented less than a third of the cases of dysentery, and as we have shown the probability that most of the other two-thirds were of bacillary origin as well as perhaps some that were reported as amebic, we shall not be greatly in error if we assume that the true proportion should be not far from five cases of bacillary dysentery to each amebic case.

TABLE 53.—*Dysentery (all types). Primary admissions, United States Army, 1917 to 1919 shown by etiological types. Total cases in the United States and Europe. Absolute numbers*

	Cases	Bacillary	Balantidic	Amebic	Other protozoal	Unclassified
Total dysenteries in 1917	688	69	2	291	3	323
United States	484	50	0	195	2	237
Europe	41	3	0	10	1	27
Total dysenteries in 1918	3,573	325	6	428	30	2,784
United States	883	70	2	239	14	558
Europe	2,431	244	4	105	15	2,063
Total dysenteries in 1919	577	66	2	207	----------	302
United States	151	3	0	62	----------	86
Europe	188	31	0	43	----------	114
Total for the period	4,838	460	10	926	33	3,409

A few cases, as shown in the tables, were reported as of balantidic or other protozoal origin. The former organism is generally recognized as occasionally pathogenic with the production of chronic dysenteric symptoms. As for ciliates or other protozoa, however, the evidence of their pathogenicity is very doubtful, and the opinion is rather generally held among those qualified to judge that the finding of ciliates in a case of dysentery is an accidental occurrence without significance etiologically. In any case the number of cases so reported was so small as to merit no further consideration here.

PREVALENCE AND DISTRIBUTION

Bearing in mind the considerations just stated and the conclusions that in all probability the actual number of cases of true dysentery was twice that reported in the tables, and further that the reported proportion of amebic to bacillary cases can not be relied upon, but that we shall not greatly err if we assume that there were in fact about five bacillary cases to each of the amebic type, it is still possible to glean from the tables as reported information of great comparative value. It is possible to state from them the relative incidence in different countries and in different races.

Of the 4,738 cases of dysentery reported, between April 1, 1917, and December 31, 1919, 254 were in officers and 3,547 in white enlisted men. The incidence of reported cases in officers was 1.23 per thousand per annum, while that for enlisted men was 0.99. One death only occurred among the officers and 54 among the white soldiers. The latter figure gives a death rate of 0.02 per thousand per annum, while the officers' rate is too small to be considered and is recorded as 0. In the troops in the United States there were 107 cases in officers (0.86 per 1,000 per annum) and 1,261 in white enlisted men (0.64). One officer and 14 enlisted men (white), died, a death rate in each case of 0.01 per thousand per annum. In Europe there were 133 cases in officers (1.80) and 1,975 among the white enlisted men (1.34), while there were no deaths from dysentery among officers and 35 among white soldiers (an annual rate of 0.02 per thousand).

These figures show that both in Europe and in America the incidence of dysentery was higher among officers than among enlisted men, but that, among officers, the type of the disease was less severe, the death rates, low as they were, were higher in the case of the enlisted men. The incidence among officers was a little more than twice as high in Europe as in the United States and the relative proportion among enlisted men comes to exactly the same figure, in Europe being two and nine hundredths times the incidence of those in the United States. Remembering the practical certainty that many other dysentery cases occurred in the troops in Europe, we must assume that the true ratio of incidence in Europe to that in the United States was probably nearer 4 than 2 to 1. The type of the disease was more severe in Europe, or perhaps treatment less prompt and efficacious on account of battle conditions. This is shown by the difference in the case fatality in the two places, 1.11 per cent in the United States and 1.77 per cent in Europe. This difference is less than could reasonably be expected considering the difference in conditions. Comparisons of the number of cases of discharge for disability between Europe and America are valueless, as large numbers of men were so discharged in America for disease originally contracted in France. There were 70 cases discharged for disability in the United States and only 8 in Europe. The greater severity of the European cases is further shown by the average number of days lost per case, 24.6 in the United States and 31 in Europe. These figures are for all types of dysentery. A division into bacillary and amebic types would bring the figures down to such small size as to render averages valueless and conclusions unreliable.

In the Philippines, white troops encountered a more severe type of dysentery and conditions which rendered them more likely to contract the disease than was the case at home. Their rate of 8.94 per thousand per annum was more than four times the rate for the troops in Europe for the entire war period (1.34). In October, 1918, at the height of military activity in France there was a reported rate of 4.01. As this was the time when the greatest number of cases necessarily went unreported, and as by no means all of our troops in France were in the battle area, it is evident that the troops in the battle area must have been exposed to infection much more effectively than was the case in the Philippines for troops living under peace conditions. The Filipino strain of dysentery was more fatal, however, as is shown by the comparison of the case fatality rates, 1.77 per cent in Europe and 2.63 in the Philippines. The yearly death rate per thousand in the Philippines was 0.24, twelve times that of the Army as a whole.

In Hawaii, the case rate for white enlisted men was far below the average for the Army and there were no deaths. In Panama, 28 cases gave a rate of 1.42 per thousand per annum, but there were no deaths. This does not necessarily indicate a milder type of the disease, as the case fatality elsewhere was so low, from 1 to 2 per cent, that deaths would hardly be expected among 28 cases.

All the figures in the comparisons given above relate to white enlisted men or officers. Some interesting points are brought out by the study of the figures for the colored troops. (Chart XXXIX and Table 49.) In the first place, for the whole Army the incidence rates for the colored troops are 20 per cent lower than

DYSENTERY. COMPARATIVE RATES

WHITE & COLORED ENL. MEN-UNITED STATES

APRIL, 1917 – DEC., 1919

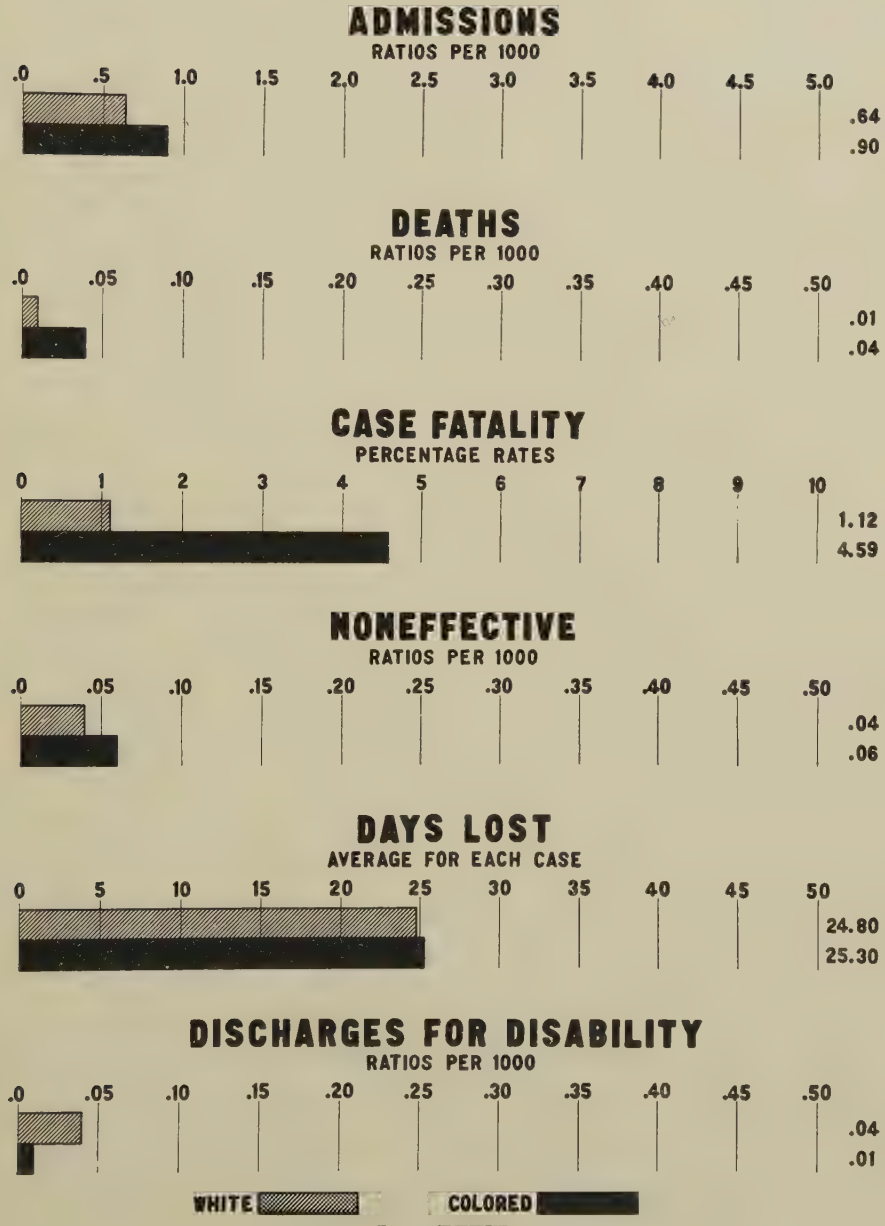

CHART XXXIX

those for white troops, while their death rates are 50 per cent higher. The negro appears less likely to become infected with dysentery, but offers less resistance to the disease once acquired. The case fatality in the colored was 3.64 per cent for the whole Army; that in the white troops 1.52. The number of cases in the colored troops, 220 for the entire period, was so small, however, as to somewhat lessen the value of this comparison. The rates for colored troops were lower in Europe than in the United States. This striking difference must have been due to the large proportion of colored troops engaged in work under the better sanitary conditions of the Services of Supply. That the rate was actually lower than in the camps at home may be interpreted as supporting the idea already advanced that seasoned troops are less susceptible to intestinal infection than are recruits. In the Philippines the colored incidence rate of 2.92 was also strikingly lower than the rate for the whites, and there were no deaths among colored troops. Here again the small number of cases involved prevents drawing conclusions.

In Hawaii there were no cases of dysentery among 3,319 colored soldiers.

Of the native troops, serving in their home environment, the Filipinos and the Porto Ricans showed to poor advantage, having the highest incidence rates, 5.98 and 6.76, respectively, after the white troops in the Philippines. The number of deaths was so small as to render averages without value, but their rates as shown were far above those of the Army as a whole.

INCIDENCE BY MONTHS

Chart XL shows the varying monthly incidence of the total reported cases of dysentery in enlisted men in the United States and in Europe. It is seen that there is some tendency for the occurrence of higher rates during the summer months, with a distinct lessening of the incidence in cold weather. In the United States the rates were higher during the first three months of the war period than was the case at any time later. This fact already has been mentioned in the discussion of the incidence of the total diarrheal group. The reasons for the high rate at this time are not apparent. Of the 125 cases of dysentery reported from the white enlisted men in the United States for these three months, 57 were of the entamebic type, only 3 recognized as bacillary, and the balance, 65, were unclassified etiologically. These figures suggest that the accessions to the Army during that period of voluntary recruiting brought in an unusually large number of persons infected with the entameba. From this initial high point in June, 1917, there was a nearly uniform gradual fall in the rates until February, 1918, when they began to rise toward the second relatively high point in June of that year. From June, 1918, until May, 1919, the tendency was again downward, although the winter fall was not as low as in the previous year. From May, 1919, to the end of the year there were irregular rises and falls in the rates, but the absolute numbers of cases were so small at this time that the figures possess little value. It can be said, however, that there is little or no indication of a definite summer rise in 1919. Chart XXXVIII, which shows the monthly incidence rates for the bacillary and entamebic types of dysentery separately, together with the unclassified group, shows also

that in general the curves of the three classes of cases follow the same course with such minor divergencies as are to be expected from the small numbers of cases involved.

In Europe, too, a relatively high rate was observed in the summer of 1917. This is of little significance, however, as it was the result of seven cases in a

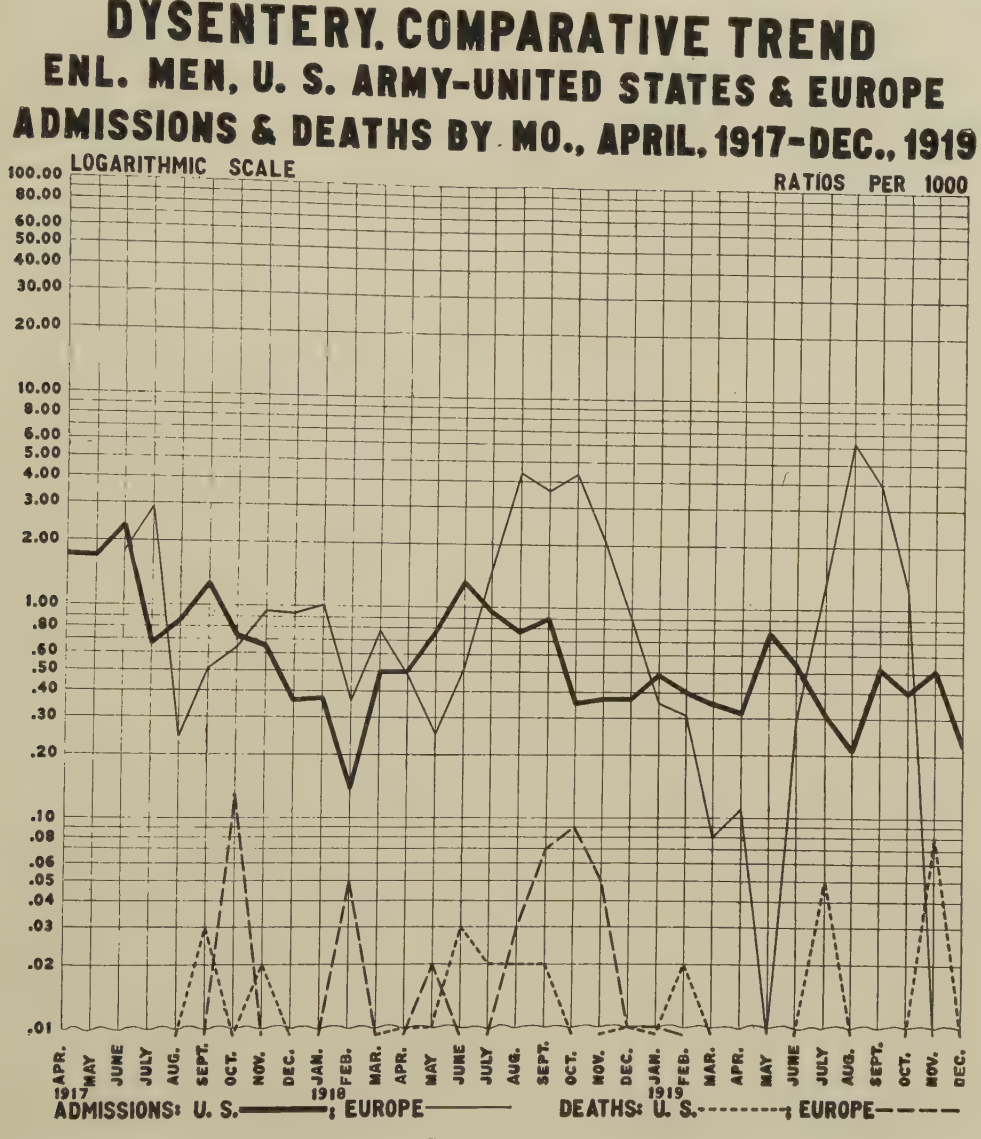

CHART XL

strength of about 29,000. Two of the cases were reported as bacillary, one as entamebic, and four were unclassified. During the winter of 1917–18 the rates in Europe did not fall as low as those in the United States, but the summer rise was delayed until July, when decided military activity began, and a decidedly high rate prevailed until after the armistice began. From then until the follow-

ing summer the Army in Europe showed very low rates, much lower than was the case at home during the same period. In August and September, 1919, however, the rates again shot up to reach a point higher than was reported at any time during active operations. This outbreak, however, consisted of only 22 cases in a strength of about 48,000 men; 15 of the cases were recorded as bacillary, 1 as entamebic, and 6 were not classified. Perhaps the fact that at this time the army of occupation had received a large number of newly recruited replacements may account for this small outbreak. Leaving out of consideration this late peak and the one of July, 1917, on the grounds that the number of cases involved was too small to be significant, it is seen that the only high rates in the Army in Europe were those which occurred during periods of intense military activity. The conditions which of necessity prevailed during those months of battle will be described later. The death rates from the dysenteries, both in Europe and America, fluctuated so irregularly, due to the small number of cases involved, as to make their consideration useless. The same considerations prevent any conclusions from being drawn from the monthly incidence of cases among colored soldiers, or the troops in other countries than the United States and Europe.

ETIOLOGY

In spite of intensive study on the part of all the armies involved, the World War added very little of moment to our knowledge of the etiology of these conditions. Much work was done in the laboratories on the specific etiological agents, particularly of the bacillary types, and much experience accumulated confirming the knowledge previously attained as to the importance of food, feces, flies, and fingers in the mechanical transfer of the pathogenic agents. The influence of climate has long been known, and the higher rates to be expected in tropical and subtropical countries were experienced during the war as shown by the incidence in the Philippines and to some extent in Panama. The effect of race has already been discussed, and it has been shown that the colored soldier appeared to have less tendency to contract dysentery than the white soldier, but that once attacked his chances of death were greater.

More interesting and important is the consideration of the predisposing causes incidental to war conditions as shown by reports from the American Expeditionary Forces. In the camps at home conditions were well under control. In battle sanitary discipline usually was impossible of enforcement, and during the military operations at Chateau Thierry, St. Mihiel, the Argonne Forest, and elsewhere dysentery and other diarrheal conditions prevailed in epidemic form. Of the many descriptions of such outbreaks a few have been selected to give an idea of the conditions which prevailed.

August 6, 1918, a mild type of bacillary dysentery was reported in the First Army and a request made of the director of laboratories at Dijon to send an officer to investigate it.[8] Accordingly a medical officer reported at First Army headquarters [9] and began a study of the epidemic which had existed in that sector since early in July. It was difficult to determine the prevalence of the disease, as perhaps not more than 2 per cent of the cases were hospitalized and sick call was held very irregularly. At the time of the call for an investgation the 3d Division had 500 cases, with 60 in hospital, the 28th Division 300

cases, with 1 in hospital, and the 32d Division 1,200 cases, with 20 in hospital. In the 1st Battalion, 165th Infantry, it was estimated that 70 per cent of the command had diarrhea. The nature of the disease is shown by the following quotation from the report of the investigator.[9]

The large majority of the cases were clinically characterized by a simple though severe diarrhea, usually coming on suddenly and, in some cases, resembling the effects of a saline purge. Many cases subsided without treatment of any kind. Many yielded to simple treatment with saline cathartics, or castor oil, followed by bismuth. A great many cases persisted for three or four days and a percentage variously estimated at from 3 to 5 lasted longer and had blood and mucus in the stool. About the same percentage had a temperature of 100° or over, and a number of cases were seen by the undersigned in which the temperature was 102°, some even going up to 104°. In these cases also there was tenesmus. In many cases there were systemic symptoms consisting of pain in the muscles and back and feeling of great prostration. In the writer's own case, and in that of several nurses and doctors observed, systemic symptoms and prostration were noted. Then the condition was one of diarrhea which in perhaps 90 per cent of the cases was not accompanied by severe systemic symptoms, disabling the men merely for one, two, or three days. Among these cases, however, there were more severe ones, some of which took on the form of moderate true dysentery, a very few showing the picture of severe types of dysentery.

The report stated that diarrhea of a similar type was prevalent among neighboring French troops. Water in the entire area was bad; *B. coli* was present in all examinations, and it could not be regarded as safe without chlorination or boiling. Efforts at chlorination had been general, but it was frankly stated that during the time of battle it was quite impossible to chlorinate the water for the men in the more advanced posts and later it was found that water was not being chlorinated in many commands, owing in some cases to the difficulty in obtaining calcium hypochlorite. In this connection the investigator stated:[9]

It is our opinion that the disease may have been started by the drinking of unboiled water from contaminated sources and that some of it is being kept going in this way; nevertheless that this was not the only and main cause of the continuance of the disease was shown by such examples as the following: Mobile Hospital No. 2 had had nothing but chlorinated water since the beginning and have taken good care of their latrines, but have always been next to units with open latrines and many flies. At least 10 per cent of the command has had diarrhea. The 146th Field Artillery, as reported by Captain Stark, had only boiled water for a short period during which diarrhea appeared. Since this command, however, was subsequently scattered and detachments could not be controlled as far as drinking from unauthorized sources was concerned, water could not entirely be excluded as being in part at least responsible, and 8 out of every 10 men have had the disease.

Sanitary conditions throughout this entire area were atrocious. At first, of course, there were many unburied bodies of men and horses throughout the area; at the time of the arrival of the undersigned, human bodies had been buried, but there were still many unburied horses. The writer no longer saw any unburied human bodies, but was told that until a few days before August 10 there had still been unburied bodies and many had not been buried very deeply. Major McKoy told the writer of some German bodies that he had seen several days after the writer arrived, buried with the hands sticking out of the ground, and there were areas of the country in which on riding through in an automobile one passed through a strongly noticeable stench.

Feces disposal except in a few instances was in a condition of utter neglect. To describe well-cared-for latrines would consist merely in picking out a few exceptions. The wretched conditions of the latrines applied not only to the front and forwarded areas, but also to areas as far back as Ussy. Many latrines were seen, some at Ussy, some in the town

of Chateau Thierry, and many in other places, consisting of shallow ditches, half or more filled with feces, with no attempt whatever to even cover them with dirt. Flies swarmed in and about them, and in some cases such as the latrine in the Chateau de la Foret near Ville Moyenne, and one in the medical supply depot of the 32d Division in Chateau Thierry, they were within short distances of messes. In addition to this, feces were deposited without any regard to latrines. In many of the woods occupied by troops there were piles of feces here and there throughout the area, on the ground, uncovered, with the paper used for cleansing purposes scattered irregularly about them. This was true not only of woods in the forward areas, but in such places as gardens at the backs of houses, such as, for instance, the one mentioned above in Chateau Thierry at the medical supply depot of the 32d Division. Again the men in the forward areas had made use, for defecating, of the shallow trenches dug for the immediate protection of a few men at a time, and no attempt had been made to cover them. This condition was true of places like the woods occupied by the 304th Field Artillery, and at Moreuil where the 77th Division units entered places previously occupied by units of the 4th Division and found them in the condition described above.

The abundance of flies was greater than the writer has ever seen anywhere before. This was probably due to the fact that the areas had been so thickly covered by breeding places, dead bodies of animals and men, and manure, and because of the coincident hot weather. During the early part of the writer's stay it was impossible to sit at a mess and eat any of the food placed on the table before myriad flies had settled upon it, and the tables in the kitchen and the food in the kitchen were at all times covered with flies.

The investigator concluded his report by saying that it was believed the epidemic of diarrhea which had been prevalent in the Paris group of the First Army was not due to any single cause. It was believed to have been started by the drinking of unchlorinated water and the contamination of food by feces; and kept alive chiefly by flies in this latter manner.

Medical officers were advised by the chief surgeon, A. E. F., of the insanitary conditions as follows:[10]

Intestinal flux has been quite prevalent recently in the American Expeditionary Forces. Whether we call it cholera morbus, dysentery, diarrhea, enterocolitis, or acute intestinal indigestion, we can not blink the fact that the causes of practically every case have been preventable and well within the control of the officers and men of the American Expeditionary Forces. The ingestion of dirty food and water is the simple and the correct explanation of the extensive epidemics which have caused a large burden of unnecessary suffering and inconvenience to our men in every part of France. The dirt has in 99 per cent of the cases been our own dirt and the food and water have been of our own providing. Feces have got into the food. All varieties of infecting organisms familiar to dwellers in temperate zones and plenty of tropical organisms have been identified. Among them the commonest have been Shiga, Flexner, Hiss-Y, Wheeler, paratyphoid, and the *Entameba histolytica*.

Do not unload the responsibility for summer diarrhea upon the filthy fly; carriers—i. e., men sick with diarrhea, typhoids, dysenteries, etc.—have served food in many kitchens. Officers and men, even in parts of France far from the turmoil and disorganization of the recently captured areas south of the Vesle, constantly drink water from unapproved sources in utter disregard of orders issued for their protection. A diarrhea of only one day, followed by three days of constipation, in a negro private of Engineers was found to be due to the Flexner bacillus. Most of those clinically recovered from what seems a simple dietetic diarrhea continue, as do typhoid convalescents, to spread their infection by hand contact with their fecal discharges. That France has been well seeded must be acknowledged if one will but count the harvest. It is verily in our own hands to prevent a continuance or a recurrence.

This graphic picture of the conditions allowed to persist after a great battle, as well as the opinion expressed from headquarters, shows what may be expected when the lessons of sanitary discipline have not been sufficiently

well ingrained upon new troops. Had the germs of cholera or even of typhoid fever been present instead of the comparatively mild strain of dysentery bacilli, the results would have been calamitous. That the American Expeditionary Forces learned its lesson and perfected its sanitary discipline is shown by the remarkably low rates for intestinal diseases which followed the signing of the armistice and to which attention has already been called.

The conditions just described served as a causative factor in the occurrence of both major types of dysentery as well as of other intestinal infections grouped in the reports as diarrhea and as enteritis and colitis. The results of such conditions have long been known and they are repeated here only to emphasize the lesson they teach.

In the matter of specific etiology of the dysenteries little of importance was added to the sum of our knowledge by the extensive research conducted not only in the laboratories of the American forces but also by all the other armies engaged. It would appear from the reports that the outbreaks of dysentery during the period of active military operations differed from those usually occurring in civil life in being of mixed etiology. In civil life an outbreak of dysentery is usually the result of one type of organism and all cases show the same type and all are directly or indirectly due to the same source of infection. In such conditions as those just portrayed, where perhaps hundreds of thousands of men are involved, the chances for the spread of infection are so favorable that several different strains or varieties of organisms find it easy to get a foothold and so not all the cases of the same outbreak are due to the same bacterial agent. In the outbreak described, the investigator [9] reported that:

> In several instances, dysentery bacilli were isolated which agglutinated in Shiga serum, but showed some slight irregularity on the Russell double sugar medium. But since the stock Shiga bacilli brought from Dijon showed the same irregularity on this medium, one felt justified in regarding these organisms as of true dysentery. In one case bacilli of the Flexner type were isolated. Dysenterylike organisms, but unidentified, were isolated from other cases. In two cases paratyphoid bacilli, probably *B. paratyphosus* were isolated from the blood.

The difficulties of isolation of this group of bacteria even under favorable circumstances have been described. It is therefore to be expected that no large proportion of successful isolations will result from any given outbreak. A few typical instances of investigations in the field follow.

In July, 1918, an epidemic of diarrhea was reported among the personnel of the 355th Infantry at Grand.[11] During the 17 days covered by the report there were about 170 cases. Examination of the stools was negative for organisms of the typhoid-dysentery group and for amebæ. The blood was also negative. The outbreak was attributed to the use of polluted water.

An outbreak of diarrhea in August, 1918, in A. R. C. Base Hospital No. 111 and in Evacuation Hospital No. 5, at Chateau Thierry, was investigated.[12] Eighty cases were examined bacteriologically. *B. dysenteriæ Shiga* was found in 4, the Flexner variety in 1, the "Y" type in 2, and the *B. paratyphosus B* in 2.

An investigation of an epidemic among troops in Camp No. 1 and troops in the vicinity of St. Nazaire, in August, 1918, failed to reveal any organisms of the dysentery group.[13] The outbreak was thought to be due to bacterial infection of a mild type and spread most probably by water and flies.

An officer of the base laboratory, intermediate section, reported cases of diarrheal disease at Romorantin and Gievres.[14] No cases of dysentery were diagnosed at the former place, but diarrhea had been common. At Gievres one case each yielded *B. dysenteriæ* (Morgan 1) and *B. dysenteriæ* (Shiga). The cases were not of a severe type.

An epidemic in the 37th Division was investigated and in October, 1918, it was reported that the Shiga bacillus had been isolated from soldiers and from civilians living in the vicinity.[15] The cases were attributed to water and to contact infection through flies.

The nature of an atypical dysentery-like bacillus found at the embarkation hospital, Newport News, Va., was investigated in September, 1918.[16] The theory was advanced that the change in environment resulting from any intestinal disturbance, constipation, diarrhea, etc., invariably changed the normal flora and resulted in an increase of atypical, nonlactose, fermenting bacilli which often outgrow the causative agent. The conclusions drawn from this investigation were as follows:[17] (*a*) The investigation failed to establish any causal relationship between atypical bacilli and dysenteric infection. (*b*) Repeated bacteriological tests are of value in making a diagnosis. (*c*) Where bacteriological results are negative or doubtful, serological tests may prove of value in establishing the cause of infection.

The importance of early examination of stools was shown by the experience with 1,050 cases from which 158 successful isolations were made. Sixty-eight per cent of the successful isolations were made in the first five days of the disease, after which the percentage of positive results rapidly diminished whether the dejecta remained characteristically dysenteric or not.

During the World War there was a tendency on the part of some workers further to subdivide the already complicated group of dysentery bacilli. Thus several varieties of para-Shiga and of para-Flexner bacilli made their appearance. The truth will probably prove to be that there are two species of dysentery bacilli represented by the Shiga and Flexner types, and that other slightly different organisms are varieties of the two main species which will prove to be more or less interchangeable. The British investigators, Willmore and Shearman,[5] made the statement that almost weekly a new type of bacillus, nonmotile Gram-negative anaerogenic, nonlactose fermenting, turned up on their plates. Each new type showed infinite gradation affinities with, and divergence from, the classical in its bearing toward recognized agglutinating sera and fermentation of sugars.

From the consideration of all the reports it is apparent that we emerged from the war with the original Shiga type as the most important etiological factor in the bacillary dysenteries; the Flexner comes second. There are several allied organisms beside the paratyphoid B which seem to have entered into the production not only of true clinical dysentery but of the milder diarrheas as well.

Little has been added to our knowledge of the etiology of entamebic dysentery as the result of the war. Two new species of apparently nonpathogenic amebæ were discovered in British laboratories. The *E. nana* of Wenyon and O'Connor,[18] and the *Dientameba fragilis* of Jepps and Dobell.[19] The former is important in the diagnosis of entameba carriers, as the cysts at times

resemble those of *E. histolytica*. Kofoid, Kornhauser and Plate[20] found *E. nana* to be the commonest ameba found in returned American troops in the large series of examinations which they conducted.[c]

CARRIERS

Opinions have been divided as to the importance of carriers in the epidemiology of bacillary dysentery. The importance of the carrier in entamebic dysentery is unquestioned. Russell[21] regarded acute and chronic carriers of dysentery bacilli as equally as important in the propagation of dysentery as are typhoid carriers in the spread of typhoid fever. He arbitrarily considered a patient a carrier if bacilli persisted in his discharges more than three months from the date of first symptoms. There is usually a clear history of dysentery. Carriers of the Flexner bacillus may remain free from symptoms and show no abnormalities in the stools. Shiga carriers, on the other hand, are more apt to present the picture of chronic cases, seldom recovering, even for a short time, sufficiently to be considered healthy. He called attention to the intermittent character of the discharge of bacilli in known carriers.

The carrier of dysentery bacilli, according to Nichols,[22] is apparently of less importance in the spread of bacillary dysentery than are carriers in the spread of typhoid fever and cholera. There are fewer true carriers in bacillary dysentery; the individual carrier is less chronically ill and excretes fewer bacteria. The spread of infection is usually due to acute and chronic cases. Incubationary carriers are known; however, in view of the absence of a test for susceptibility, and in view of the relapsing character of the attack, it is difficult to diagnose them. In temporary convalescent carriers, the excretion of bacilli diminishes after clinical recovery. According to Nichols, the number does not become low for about two months, and it requires repeated examinations to exclude the carrier state. Chronic convalescent carriers on the other hand, running up to 1 year, occur in from 1 to 5 per cent in different series. It is difficult to draw the line between relapsing carriers and chronic cases. Nichols and Russell agree on the difference between Flexner and Shiga cases from the carrier standpoint. The Flexner cases are more apt to result in the carrier state while the Shiga cases tend to become chronic. Nichols concluded that contact carriers have usually been considered rare, but with improvement in the technique of examination they have been found more frequently.

The percentage of cases that became carriers and the proportion of examinations that resulted in positive findings of dysentery bacilli were variously reported by different workers. Arkwright, Yorke, Priestley, and Gilmore[23] examined 50 dysentery convalescents for the carrier state. The cases varied from three to six months after the onset of symptoms. The Shiga bacillus was found in two and *E. histolytica* in nine. Kennedy and Rosewarne [24] examined several hundred typhoid and dysentery convalescents for the detection of carriers. More than 5,000 examinations were made. The results showed 6 dysentery carriers, of which 3 were of the "Y" type and 3 Shiga. Fletcher and Mackinnon[25] examined 935 dysentery convalescents and 847

[c] For further details in this connection, consult Chapter XIX of this volume.

convalescents from other diseases, such as enteric and trench fevers. Among the dysentery convalescents, 6.95 per cent were found to be dysentery carriers; 2.78 per cent persisted in the carrier state. There were 58 carriers of the Flexner organism and 13 of the Shiga. Of the nondysenteric cases, 1.06 per cent were carriers of dysentery bacilli. Two-thirds of these patients gave a history of dysentery; all were of the Flexner type. All the Shiga carriers were persistent and suffered from chronic dysentery and mental depression. The Flexner carriers were usually in good condition and fit for work under favorable conditions. The carrier of Flexner bacilli does not excrete the organism continuously but intermittently, with periods of perhaps five or six weeks during which it can not be found. This renders the diagnosis of the carrier state extremely difficult and indicates the necessity of frequent examinations over a considerable period before a given patient may safely be considered free from bacilli.

According to Dopter,[26] the main source of entamebic infection during the war was the presence of carriers of the organism among the French colonial troops from North Africa. These men infected the soil of the trenches they occupied, and healthy troops relieving them became infected in their turn. Thus with the general interchange of troops the infection became widely scattered. The number of cases was never large enough to menace military effectiveness, but sanitarians were preoccupied with the thought that the creation of an army of entameba carriers might present a serious problem to the countries concerned on the return of their soldiers to civil life.

Sporadic cases of entamebic dysentery have been known for years in all parts of the United States, but the condition has remained somewhat of a pathological curiosity. However, during the Mexican border mobilization in 1916, Craig[27] identified the organism in 158 cases of dysentery among some 110,000 men. The cases were milder than those usually seen in the Philippine Islands, possibly because treatment was instituted earlier. True and convalescent carriers were demonstrated and were regarded as the source of the disease. There was no evidence of contact infection.

Dobell[23] examined 200 soldiers for *E. histolytica* as a routine measure and found 22, or 11 per cent, infected. Half of these denied any history of diarrhea or dysentery. Among these men, 4 were undoubted contact carriers. Matthews and Smith,[29] at the Liverpool School of Tropical Medicine, examined the stools of 4,062 dysentery patients from the Western Front and found 12.1 per cent infected with the ameba.

The degree of infection in American troops both at home and abroad is indicated by the results of examination of returned soldiers at Debarkation Hospital No. 3 at New York City and of home-service men at the port of embarkation; 230 overseas men and 576 home-service men were thus examined.[20] Of the former, 12.8 per cent and of the latter 4.3 per cent were found to harbor *E. histolytica*. Very few of the men had dysenteric symptoms at the time of examination. Later, an examination was conducted at the University of California on students who had served as soldiers overseas. On this occasion repeated examinations were possible and each of 154 men received an average of 3.8 examinations. Of these men, 67 per cent were found positive for *E. his-*

tolytica. The authors of the investigation conclude that the number of ameba carriers in the country must have been substantially increased by the return of infected soldiers from overseas. These figures confirm the statement earlier made that the proportion of carriers of *E. histolytica* who manifest no clinical evidence of their condition is very large.

SYMPTOMATOLOGY AND PATHOLOGY

The clinical course of the average case of dysentery observed during the World War naturally presented nothing different from the cases seen elsewhere; however, certain additions to our knowledge were made, either by American workers or by those of other armies, which deserve passing mention.

There is no discoverable record of anything to show the incubation period of bacillary dysentery. The onset was usually described as sudden, with frequent bloody stools, prostration, tormina, and rectal tenesmus. Generally, the cases were mild or moderately severe in type. No cases were described of the type resembling cholera—acutely toxic with death occurring without change in the number and character of the stools. Russell,[21] in his description of bacillary dysentery, states that the stool itself is quite characteristic and at the height of the disease is quite unlike the stool in any other disease, not excluding amebic dysentery. It is small and consists exclusively of blood and mucus, without a trace of fecal matter. Under the microscope one sees red blood cells in enormous numbers, and epithelial cells in masses; they are thrown off by the mucous membrane. These are often to be recognized as columnar epithelial cells, arranged like closely aligned pickets on a fence, like a typical textbook picture. In addition, single epithelial cells in all stages of swelling, degeneration, and necrosis are seen. The single swollen cells are often roundish and suggest at first quiescent amebæ, but they do not possess the power of motion or the ability to send out pseudopodia. They may also be readily distinguished from amebic cysts by the large size and different character of their nuclei. These various elements are embedded in masses of glairy and stringy mucus. As the disease progresses and increases in severity the character of the stool changes from that described above, the epithelial masses increase in size until one sees sloughs of large ulcers, or even a pseudomembranous cast of the entire circumference of the gut. Under the microscope it is no longer possible to make out the structure of the epithelial cells, since the entire mass is coagulated and necrotic. The fluid part of the stool is no longer watery, but serous, and dark from altered hemoglobin. Such stools are extremely offensive.

Bacillary dysentery usually runs an acute course, terminating with recovery in the course of a few days or weeks. A small percentage become chronic or terminate fatally. Although not always true, this was the experience of the Army during the World War. The case fatality was 2.17 and but 1 case was discharged for disability.

The chronic cases suffer from depression, emaciation, and relapses. Jacob[30] described a series of cases in which relapse occurred between the nineteenth and twenty-first day. Normal temperature preceded the relapse by one to three weeks. Intestinal symptoms were absent or stools were much like those of diarrhea; however, he isolated the Shiga and Flexner strains from the stools

during the relapse. Headache and joint pains were frequently present. Pain along the colon is not an uncommon complaint. The proctoscope often reveals ulceration in the lower bowel.

PROGNOSIS

The prognosis of dysentery as observed during the World War is very favorable. Of the 4,738 cases of all types of dysentery reported, but 73 terminated fatally. This gives a case fatality of 1.54 per cent. Taking into consideration the admittedly large number of cases never reaching the hospital, or being entered upon the records, it is evident that even this low fatality is stated much too high. The prognosis appears to be decidedly less favorable in the colored race than in the white. The case fatality in 220 cases in negroes was 4.55 per cent, while of 3,547 cases in white enlisted men, but 1.48 per cent died. Again, the small number of cases in the colored, 220, with 8 deaths, introduces a large probable error and lessens the value of the comparison. The same considerations render the figures for case fatality of the various types of dysentery of less value than would be the case had a larger proportion been classified etiologically in the reports. The case fatality for bacillary cases was 2.17 per cent, while that of the entamebic cases was 1.29 per cent.

The entamebic cases were responsible for 85 of the 86 dysenteric cases discharged for disability during the war. This is to be expected on account of the chronic and relapsing character of this disease. Indeed, Craig [27] recommended that the carriers of the entameba who are not readily cleared up after a reasonable period of treatment should be discharged from the service as a measure of protection to uninfected troops. Experience has shown that such men can not stand the strain of active campaigning and soon suffer relapses and become a burden rather than an asset to the service. The average case of bacillary dysentery lost 19.6 days from duty; the amebic, 34.6. The unclassified dysenteries averaged 21.6 days lost, a figure much nearer that of the bacillary group than that of the amebic cases. This confirms the deduction previously made that the vast majority of the unclassified cases were of the bacillary type. Prognosis is of course modified by the promptness and efficacy of treatment and hence proved more favorable in the training camps in the United States than was the case under battle conditions in France.

AUTOPSY FINDINGS

There are on file in the Surgeon General's Office the protocols of 35 autopsies performed on dysentery cases. These are classified as follows: Bacillary dysentery, 7 cases; amebic dysentery, 8 cases; mixed infection, bacillary and amebic, 3 cases; dysentery with negative laboratory findings, 9 cases; complicated dysentery, 8 cases (pneumonia, 4; ulcerative endocarditis, 2; influenza, 1; and tuberculosis, 1).

The autopsy findings in the bacillary cases were those commonly seen in this type of dysentery. In 6 of the 7 cases the heart showed acute myocarditis. In 5 cases occurring in the American Expeditionary Forces the diagnosis of bacillary dysentery was made by laboratory examination of the stools. Two cases were diagnosed a few days before death, the patients having been admitted

in extremis; one case dying from Flexner infection showed slight degenerative changes in the liver.

All of the amebic cases coming to autopsy showed abscess of the liver. The entameba was found in the pus of the abscess, in the intestinal ulcers, or both. The lesions differed only in extent, and consisted of ulceration of the large bowel and in some cases the lower 2 feet of the ileum. The ulcers were generally very numerous and at times confluent, so as practically to destroy the mucosa. No perforations were reported. The other changes found in these cases were secondary to perforation of abscesses into the pleural or peritoneal cavities. The liver abscesses were located in the convex portion of the right lobe of the liver in all cases but one, which involved the left lobe only. The diagnosis had been made clinically in but one case; in 2 others it was suspected while of the remaining 5, tuberculous peritonitis was diagnosed twice and appendicitis, lobar pneumonia, and bronchopneumonia once each.

From the necropsy standpoint, 8 of the 9 cases of dysentery coming to examination without laboratory diagnosis were most probably bacillary dysentery. The location of the lesions, edema of the intestinal wall, areas of ulceration, pseudomembrane, and necrotic mucosa indicate the grounds on which this conclusion is based. In one case without laboratory findings, the conditions resembled those of the amebic type. Symptoms had persisted for four months before death.

DIAGNOSIS

Under war conditions the diagnosis of a case of dysentery must necessarily be made usually upon clinical grounds exclusively. The differentiation of type in bacillary dysentery and even the distinction between bacillary and amebic cases require the use of laboratory equipment and trained personnel. Therefore, under field conditions, the majority of cases were reported as "dysentery, unclassified." The occurrence of a considerable proportion of unclassifiable cases of clinical dysentery among the troops in the camps in the United States shows that even under favorable conditions a specific diagnosis can not be arrived at in every case. The difficulties and uncertainties of diagnosis, and the resultant effects upon the statistics have been touched upon incidentally in previous paragraphs.

The importance of early diagnosis has been indicated in relation to the early institution of serum treatment. In the prompt identification of the bacillary forms all authorities agree that it is of first importance to secure a properly selected, fresh stool for bacteriological examination. Kligler and Olitsky[31] reported failures to isolate *B. dysenteriæ* from cases of clinical bacillary dysentery and attribute the failure to (1) improper selection of stool specimens for culture and (2) the use of unfavorable culture media. The stool selected should be one containing blood and mucus, with little or no fecal matter. It is essential to plate the stool directly, or at least very shortly after it is evacuated. Experiments with artificial mixtures of Shiga bacilli and feces showed a 50 per cent reduction in 4 hours, and from 85 to 90 per cent reduction in 24 hours when kept at room temperature. They recommended the use of a modified Endo-medium or the eosin-methylene blue medium.

A simple and satisfactory medium was devised in the central medical department laboratory, A. E. F., for the isolation of *B. dysenteriæ* from stools.[32] It consists of:

Distilled water	100 c. c.
Agar	15 gm.
Peptone (difco)	10 gm.
Dipotassium phosphate	4 gm.

To each 100 c. c. is added:

Lactose, 20 per cent solution	5 c. c.
Glucose, 5 per cent solution	1 c. c.
Rosolic acid, 1 per cent in 90 per cent alcohol	1 c. c.
China blue, 0.5 per cent in water	1 c. c.

The hydrogen ion concentration of this medium is 7.4 to 7.5 and it needs no adjustment. If the sugars are clean and white it needs no filtration. The dysentery bacilli grow as luxuriantly on this as on any other medium, and the lactose nonfermenters are readily recognized.

In addition to the precautions suggested by Kligler and Olitsky, the importance of securing, if possible, a stool for diagnosis early in the course of the disease should not be overlooked. Recent work suggests that the bacteriophage developed in the intestine after the first few days of the disease may be the inhibiting agent which causes failure to grow on the part of the infecting organism even when doubtless present in large numbers. With the disappearance of the lytic agent during convalescence it is frequently again possible to isolate the bacillus in large numbers.

The application of the agglutination test to the patient's serum as a means of diagnosis has not resulted in great success. Specific agglutinins would not be expected to develop in much concentration until the disease had progressed several days. This would militate against the use of this test in early cases when diagnosis is most important. The American opinion is voiced by Kligler,[16] who remarks that it is a well-known fact that agglutinins for the Flexner bacillus are present in fairly high concentration (1:50 or 1:75) in normal individuals. This is not true for Shiga agglutinins, which are rarely demonstrable in dilutions over 1:10. It would thus appear that the diagnosis of Shiga infection might be predicated upon a positive agglutination in specific serum at a dilution of 1:20 or over, but that Flexner infection could only be diagnosed were the test positive at a dilution of at least 1:100.

War experience has shown the fallacy of ascribing pathogenic properties to bacteria isolated from the stools of dysentery patients merely because they conform in cultural characters to dysentery bacilli. An accurate diagnosis must be based both on cultural and specific serological criteria and sometimes even upon animal experimentation. Examination of fresh stools early in the course of the attack, the use of suitable media, and skill in their use are essential for satisfactory results. A single negative examination is of little or no value.

To our knowledge of the diagnosis of amebic dysentery little was added as the result of war experience. The importance of the differentiation between *E. histolytica* and *E. nana*, especially in the diagnosis of cyst carriers, has been brought out earlier.

The differential diagnosis between the bacillary and amebic types of dysentery must be ultimately based upon laboratory findings. However, differences in the clinical appearance of the patient and in the general as well as microscopic appearance of the stool may be valuable in making this differentiation. The amebic patient, generally speaking, is less toxic, the temperature is little if at all elevated, the number of stools, although increased, is small as compared with the bacillary type, rarely exceeding 10 to 14 per day, and the course of the disease is more prolonged. In bacillary cases of moderate to severe grade there is usually a sudden onset, the patient is toxic, temperature high, stools numerous—30 to 40, or more, in 24 hours. He presents the appearance of a very sick man and the disease is usually of short duration. Descriptions of the microscopic characters of the stools in these two conditions published during the war period have been superseded by the exact cytological diagnostic work of Willmore and Shearman,[5] Manson-Bahr,[6] and others, which appear to have made the distinction easily possible on microscopic grounds.

TREATMENT

This is a subject necessarily treated differently for the different types of the disease. So, too, the treatment of the acute, initial attack must differ from that of the chronic forms in cases in which the disease obtains a prolonged hold. This latter unfortunate happening is usually the result of delay in starting treatment and is characterized pathologically by an ulcerated condition of the intestine even in the bacillary cases, and symptomatically by intermittent diarrhea, usually without much blood or mucous, but showing pus, anemia, and varying degrees of prostration. There is no record of this type of disease having attracted attention in the American forces during the World War although presenting a serious problem to some of our Allies, especially in the East. Consequently only the treatment of the acute attack will be considered here.

The most important thing in the treatment of acute bacillary dysentery is the establishment of at least a probable diagnosis. In epidemic times this is usually evident, although when both bacillary and amebic dysentery are prevalent the differentiation is important. The treatment should be along lines both specific and symptomatic. The specific treatment of bacillary dysentery consists of the administration of a reliable polyvalent antidysenteric serum in a sufficient dosage and as early as possible. This treatment has not been used extensively in the United States, possibly because severe clinical forms of dysentery are not common here and possibly because the treatment has not habitually been administered early enough on account of delay for the purpose of obtaining a bacteriological confirmation of the diagnosis before the administration of serum.

According to Russell[21] the serum is best given in large doses following Shiga's rule, 1 dose of 10 c. c. in mild cases, 2 such doses at intervals of 6 hours, in cases of moderate severity, and in severe cases 10 c. c. twice a day for 2 or 3 days. The tendency seems to be to increase the dosage, and even a dose of 100 c. c. daily has been given to severe cases with apparent benefit.

The British believe[33] that the value of the specific serum has been established and that the sooner it is administered the better. They recommend an initial dose of from 20 c. c. to 60 c. c. Bahr and Young[34] recommend administration of the serum in all doubtful cases while awaiting the results of laboratory examination. They believe that the benefits obtained by prompt administration outweigh any objections to the treatment of an occasional nonbacillary case and state that it does not act deleteriously in any case, irrespective of the nature of the disease. In a memorandum on medical diseases in the tropical and subtropical war areas, the British state that the action of antidysenteric serum is often remarkable, as much as 400 c. c. having been given in severe cases, and (apparently) it has been the means of saving the patients.[35] The French used serotherapy extensively but with varying results.[26] Among the Germans, Schittenhelm[36] remarks that, as in the case of diphtheria, it should be given as soon as possible. He recommends the intramuscular route as more rapidly effective. The dose used by the Germans was larger than that used by the Americans.

The patient should be confined to his bed, and the use of the bedpan enforced. The diet should be nonirritating and at first liquid, using the strained types of diet which leave little residue. An important point in the nonspecific treatment is the clearing of the bowel by means of salines. A method for accomplishing this is as follows: A dose of 20 c. c. of saturated solution of magnesium sulphate is given every four hours, each dose followed an hour later by 10 drops of aromatic sulphuric acid in water. This results at first in an increase in the number of stools, but within two days they are greatly reduced in number, pain becomes less, and general improvement is noted.

The following saline treatment was recommended by Balfour:[33]

℞

Sodium sulphate	gr. lx.
Acid. sulph. aromat	m. xv.
Tr. zingiberi	m. v.
Aq. menth. pip	oz. ss.

M.

This mixture above should be administered every 2, 3, or 4 hours until the stools become watery. It is claimed to be better than magnesium sulphate. Bismuth subnitrate, 60 grains, and salol, 3 grains, every 6 hours are useful in the later stages. In very severe cases, drained by the constant evacuations, Balfour recommends the Rogers cholera treatment,[33] the intravenous administration of hypertonic salt solution to restore blood volume and prevent acidosis. Ipecac and its alkaloid are without value in bacillary dysentery and opium and its derivatives are probably harmful by forcibly checking the number of evacuations and retaining within the intestine the toxin of the invading organisms.[d]

[d] With the postwar development of the cytological method of diagnosis in the dysenteries, it has become possible in the great majority of cases to render an opinion as to the type of dysentery, bacillary or amebic, within a few minutes after a stool specimen has been received in the laboratory. The use of this aid places the early administration of the serum upon a sound scientific basis; and judging from our experience in the Philippine Islands, a majority of cases could be diagnosed and treated with success in a medical echelon very close to the front, and need never reach the larger hospitals.

Little new developed from war experience in the treatment of acute amebic dysentery, although much work was done along this line. It resolves itself into the effective administration of emetine. First suggested as a remedy for dysentery in 1829 by Bardsley [37] of Manchester, it was found to be amebacidal by Vedder [38] of the United States Army (1910–11), and its use in amebic dysentery was established in 1912 by Sir Leonard Rogers.[39] The routine treatment consists in the daily administration of 1 grain of the alkaloid subcutaneously for a period of 12 days. Such a course usually causes a rapid improvement with cessation of dysenteric symptoms, but it can not be relied upon to cure the disease in the sense of completely removing the infecting amebæ. It is necessary to keep the patient in bed during such a course of emetine, not only for the purpose of controlling the diet, but also as a protection to the heart. Dale [40] showed that emetine in large doses is cumulative in its action, and that neuritis has followed its use. Two fatal cases of emetine poisoning were reported in 1916 from Base Hospital No. 2, at Fort Bliss, Tex.[41] The possible deleterious effect on the heart is pointed out by Wenyon and O'Conner, whose report describes two cases.

Attempts to develop a form of emetine administration more effective in clearing up the infection than the alkaloid alone led to introduction by Du Mez [42] of the double iodide of emetine and bismuth which contains 58 per cent of iodine, 12 per cent bismuth, and 29 per cent emetine. The alkaloid is gradually liberated under the action of the alkaline secretions of the intestine. It is less emetic in its action than is emetine alone, but may cause nausea in some instances. This may be mitigated by the previous administration of 10 to 12 drops of the tincture of opium, preferably after the patient has retired for the night and after a light meal. Under this treatment it does not appear to be necessary to confine the patient to his bed. The dose is 3 grains daily, preferably in a single dose rather than in divided doses. The treatment is continued for 12 days. This treatment is usually regarded as less effective in the removal of the symptoms of the acute state than is the subcutaneous emetine treatment, but is more effective in clearing up the carriers.

The use of emetine bismuth iodide in conjunction with the hypodermic injections of emetine would seem to be beneficial in that convalescence is established earlier and patients are less apt to become carriers.[43] But it can not be considered as a substitute for emetine, as attempts to treat acute cases with it alone ended in failure until emetine was used in addition.

Patients may be completely cured by the emetine treatment, but probably two-thirds of the cases, though completely relieved from their symptoms, still harbor the organism, as shown by the excretion of cysts. Such patients are almost sure to suffer relapse at some later date and of course are the main source of infection of others. The clearing up of carriers has thus become a major problem of the treatment. Wenyon and O'Conner [18] advised the combined oral and hypodermic use of emetine hydrochloride in the treatment of carriers. One grain of the drug is given hypodermically in the morning daily for 12 days, and one-half grain in a keratin-coated tabloid is given by mouth each evening. They reported 30 carrier cases treated by this method with no relapses. In 37 carriers treated by the hypodermic method alone, there were 10 relapses, and in 5

the drug failed to act. Of six cases treated orally, half showed either no reaction to the drug or suffered relapse. Jepps and Meakins [44] concluded that emetine bismuth iodide cured 95 per cent of *E. histolytica* carriers, and that the best method of administration is in the form of a loose powder contained in a cachet, in daily doses of 3 grains. At least 36 grains should be given in all. The Medical Research Council [45] reports on the results of treatment of 155 *E. histolytica* carriers with emetine bismuth iodide in various forms, and in doses of 3 grains daily for 12 or more consecutive days. A single first course of treatment cured 90 per cent of their cases. When they remain uncured after such treatment, the best method of retreatment is to give them a double course of the drug; that is, 3 grains daily for 24 days. Such treatment has not cured every case, but there is no evidence that those who are not curable by such means constitute more than 5 per cent of all carriers of *E. histolytica*.

In conclusion, it may be said that emetine hydrochloride, alone or in conjunction with emetine bismuth iodide, was the preferred form of specific therapy for amebic dysentery during the World War, while the use of the double salt gave the best results in the treatment of carriers.

PREVENTIVE MEASURES

The preventive measures used during the World War fall into two classes, the general and the specific measures. The former comprise nothing that was not previously known, but instructions issued by the War Department on the subject and examples of conditions under which the troops had to operate are of value. Some such examples have been given already.

Of the general preventive measures the early diagnosis and isolation of the sick, discovery, isolation and treatment of carriers, destruction of flies and prevention of fly breeding, safe-guarding of water supplies, precautions to prevent contamination of food, and the proper disposal of feces were the methods on which we depended for the limitation of the dysenteries as well as of the typhoid group and other intestinal infections. In 1917 the Surgeon General issued the following instructions relative to the causation and prevention of the dysenteries:[46]

Dysentery—Causes and nature.—Dysentery, or inflammation of the large intestine, is caused by two classes of microorganisms, an ameba and certain bacteria. The former gives rise to amebic, the latter to bacillary dysentery. The bacterial or bacillary form of dysentery is more widely distributed over the world than the amebic. While the former is found in all climates, the latter is chiefly restricted to warm countries. But persons suffering from amebic dysentery may carry the disease from a warm to a cold climate.

Sources of infection.—The amebæ and bacilli which cause dysentery are contained in the intestinal contents and are discharged with them. They are, therefore, subject to the same manner of distribution as are the typhoid bacilli, and the preventive measures to be employed are identical with those employed in typhoid fever. It may be well, however, to emphasize the common occurrence of carriers of dysentery bacilli and amebæ among exposed and recovered cases and the necessity of enforcing habits of personal cleanliness and other related measures to control the disease.

Diarrhea, etc.—In addition to dysentery, slighter and nondysenteric forms of intestinal trouble are more or less common. As the results of chill or indiscretion in diet, diarrhea, griping, and even bloody stools may arise. But any case of persistent diarrhea in which blood and mucus are being discharged should be regarded as suspicious and submitted to a

laboratory examination in order to determine whether it may be dysentery. The amebæ are searched for by direct microscopic examination; the bacilli may be obtained in culture, or an agglutination test made with the patient's blood to determine their presence.

The intestinal group of diseases.—(*a*) Typhoid and paratyphoid fever, cholera, with amebic and bacillary dysentery form a group of intestinal infections in which the causative microorganisms are discharged with the excreta and gain access to healthy persons through the mouth. The general principles of their prevention are practically identical. The first effort should be made to destroy the infectious agents at their source, namely, in the discharges from the intestine. The next effort should be to control the water and food supply and the personal habits of the men, so that any of the microorganisms which escape destruction may not find their way into the digestive tract in a living condition.

(*b*) No man should be employed as cook or handler of food or water who is a carrier of *B. typhosus, B. paratyphosus, A* or *B,* or cysts of *Entameba histolytica.*

(*c*) Stools of all cooks and food handlers (including handlers of water and drivers of water and ice wagons) will be examined for typhoid, paratyphoid A and B, and dysentery bacilli, and for cysts of *Entameba histolytica.* In the case of enlisted men, notation of positive findings should be made upon the service record.

As missed and mild cases are undoubtedly responsible for much spread of infection, it is advisable, when military considerations permit, to hospitalize, at least for a brief period, as large a proportion of these cases as possible to permit the disinfection of dejecta, clothing, linen, etc. Such a measure is particularly practicable in the case of troops not actively engaged with the enemy.

Specific vaccination against the dysenteries, using a polyvalent vaccine prepared along the same general lines as is that against the typhoid group, had been practiced to some extent before the war. According to Russell,[21] such measures are theoretically correct and under suitable conditions should give good results. Antidysenteric vaccination was not used as a routine measure in the Army during the World War and practical experience confirmed the judgment that it is rarely necessary. Dysentery was not, except for very brief periods, an important cause of disability in the areas occupied by our troops. The main objection to its routine use, unless special conditions demand it, has been the severe character of the reaction induced by effective doses of the vaccine. To overcome this difficulty several expedients were tried. One was the introduction of sensitized vaccines by Boehnke and Elkeles[47] in 1915 and by Gibson[48] in 1917. The Boehnke prophylactic was prepared for the German Army by adding the *B. dysenteriæ* toxin and antitoxin in varying proportions to an emulsion of dysentery bacilli of various types. This was termed "dysbakta." It is doubtful according to Russell,[21] whether the advantages of such a mixture are marked enough to justify the use of repeated small doses of the contained horse serum. Dopter[49] and Besredka[50] attempted to produce vaccines which could be administered orally. Under experimental conditions they attained some degree of success and the application of their methods to the human is still under trial. So far, the degree of success attained has not been such as to make oral vaccination the method of choice.

The application of the lipovaccine to the prevention of dysentery was attempted. Officers at the Army Medical School[51] produced such a vaccine. It contained 2,000,000,000 Shiga bacilli, with the same number of the Flexner and of the "Y" types, per cubic centimeter. The local and general reaction

to a dose of 1 c.c. of this vaccine was said to be no greater than that induced by the regular saline triple typhoid vaccine. Olitsky[52] confirmed the safety and practicability of producing a vaccine by the emulsion of various types of dysentery bacilli in oil. The method is still in its experimental stage. A main difficulty appears to be the attainment of effective sterilization of the vaccine.

Against amebic dysentery the same general hygienic measures as have proven of value against the bacillary form should be effective. The prophylactic use of emetine might be of value in situations where a high incidence of the disease was to be expected. The French under these conditions used 4 or 5 grains of emetine hydrochloride dissolved in tincture of opium in the proportion of 1 to 15. Of this mixture, 8 to 10 drops were added to a cup of strong tea and taken each night. The method is comparable to the prophylactic administration of quinine in malaria and might serve an equally useful purpose.

NONSPECIFIC DIARRHEA, ENTERITIS, AND COLITIS

The affections included in this heterogeneous group of generally mild diarrheal affections were classified under one heading or the other, according to the individual preference of the reporting officer. If his preference was for a symptomatic diagnosis, the case was called diarrhea; if for a pathologic or anatomic designation, it became enteritis or colitis on the records.

The occurrence of these diseases is shown in the basic table from which most of our figures have been drawn—Table 49. The totals shown in Table 49 for the group as a whole include the dysentery cases as well, but the percentage of the total cases represented by the dysenteries as reported is so small, about five, that their inclusion is without effect upon the relative position of the different personnel groups when the latter are compared. Therefore it would be a work of supererogation to go again into the effect of geographical location of troops, race, etc., in regard to the incidence of these diseases. What has already been said with regard to the group as a whole is equally true of the nonspecific diarrheas and enterocolitis.

In the discussion of the true dysenteries it was brought out that many such cases were undoubtedly reported under the nonspecific headings for various reasons which were there discussed. It seems probable that most of the fatality associated with the conditions now under discussion was the result of this inclusion among them of cases of true dysentery. Another possibility is that a certain number of chronic cases were also included among them. Most of such cases were probably classified in the tables under the heading "Miscellaneous diseases of the intestinal tract," but others could easily have been reported as "chronic diarrhea" or "chronic colitis" and so have become included in our figures. Such chronic cases would have tended to increase the fatality of the group, its proportion of discharges for disability, and the number of days lost from duty over what would have been the case had only acute cases been reported.

In spite of such probable inclusions, the type of disease represented was evidently mild, as shown by the average duration of the cases. The figures show that these cases in the United States occasioned only from three to five days' loss of time per case. In Europe, owing to the inclusion of a considerable

proportion of the more severe dysenteries, and to the loss of time occasioned by the delays in reaching hospitals, the average time lost was longer. It is evident, however, from the descriptions of epidemics in the battle zones that the great majority of the diarrhea cases were not severe enough to go regularly on sick report.

No specific statement of the etiology of these milder diarrheas as distinct from the dysenteries is possible. Dietary indiscretions, or more frequently the character and condition of the only food available, have been blamed in some instances. However, in the latter case the actual cause of the trouble may with more probability be considered to have been bacterial infective agents contained in the food. The same may be said of the drinking of polluted water. Such water probably always contains the germs of dysentery or typhoid or paratyphoid fevers, and the result of its use would naturally be the mixed type of epidemic seen in France.

The monthly incidence of these conditions as shown in Chart XXXVI indicates that in the United States, where the curves were not broken by periods of military activity, there is a definite seasonal increase of incidence, culminating in July or August. At this season air temperature renders almost any food exposed to infection a suitable culture medium for bacteria of the types under consideration, and the large number of flies usually to be seen about food in connection with the filthy feeding and breeding habits of this insect provides an easy explanation of the method in which infection reaches the food.

By no means the last word has been said on the subject of the etiology of diarrheal infections. It is entirely possible that many mild attacks which occur more or less typically in epidemic form in the civilian population have a specific etiology at present entirely unknown. That most cases, however mild, owe their inception to some infective agent, whatever it be, may be considered to be proven by the close correlation between the incidence of these milder diseases with those of known bacterial etiology. Those measures of sanitation which suffice to limit typhoid, cholera, and dysentery, serve also to reduce the incidence of the milder diarrheas. When conditions permit effective sanitary discipline all these conditions are reduced almost to the vanishing point.

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CHAPTER IX

SMALLPOX[a]

The most important fact disclosed by an investigation of the records of occurrence of smallpox in the United States Army during the World War is, as might be anticipated, the demonstration on a gigantic scale, of the importance and value of vaccination as a preventive measure. Appreciation of the value of vaccine virus as a preventive agent presupposes a knowledge of the history of smallpox and the toll of human lives it took in prevaccination days, and, for that matter, in recent times, in populations not adequately protected. For example, history tells us that all the inhabitants of Greenland died during the course of one epidemic and the country was not repopulated for 300 years; that in 1707 one-third of Iceland's population of 50,000 succumbed to the disease;[1] that from 1701 to 1800 an average of 1 of every 12 persons dying in London each year died of smallpox;[2] that in 1752 during an epidemic of smallpox in Boston, with a population of about 10,000 people not immune to smallpox, about 2,000 were rendered immune by inoculation with smallpox, the only method of immunization then known, approximately 2,000 fled the city, and of the remaining 6,000 nonimmunes more than 5,500 suffered attacks of smallpox;[3] and that in two Indian (Moqui) villages in Arizona with a total population of 900 individuals, smallpox in epidemic form attacked 590 and killed 184.[4] These are a few of innumerable instances that will serve to illustrate the havoc that smallpox has wrought.

The history of military medicine of prevaccination days is replete with reports of epidemics of smallpox comparable in nature and severity with the examples cited for civil populations.

When Jenner, in 1798, gave to the world the method for controlling and preventing this disease—vaccination—this measure gradually was adopted by all civilized countries. With the passage of time and with additions to scientific knowledge, it has been possible constantly to improve the methods of preparation of the vaccine virus and to develop better and more satisfactory methods of administration, with the result that to-day the procurement of a potent, purified virus is, as compared with 30 years ago, a simple matter in all civilized communities.

In so far as military medicine is concerned the prevalence of smallpox in the French forces as compared with the German forces during the Franco-Prussian War (1870–71) offers very striking evidence of the value of vaccination. Perhaps the most conservative and most reliable statistics of the reactive prevalence of the disease in the opposing military forces are those recorded in the official German Medical History of the War of 1870–71. These figures are as follows:

	Total cases	Rate per 1,000 strength	Total deaths
French Army	14,173	540	1,963
German Army	4,835	61	278

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

General vaccination of the military forces was a matter of custom in the German Army at that time,[5] whereas in the French Army such was not the case.

During the Russo-Japanese War the Japanese forces were well vaccinated and of the million men engaged in that conflict only 362 contracted smallpox (4 per 10,000 of strength), of which number only 35 died.[6]

OCCURRENCE IN THE ARMY PRIOR TO THE WORLD WAR

A brief reference to the trend of the smallpox rates in the United States Army during the past few decades and a comparison of its prevalence during war periods are considered desirable and will bring more clearly into relief the very excellent results obtained through the application of protective measures during the World War. The admission and death rates for white enlisted personnel, United States Army, 1840 to 1919, inclusive, are given in Table 54 and shown graphically in Chart XLI.

TABLE 54.—*Smallpox—Admissions and deaths, white enlisted men, United States Army, 1840 to 1919—Rates per 1,000 of strength*

Years	Admissions	Deaths	Years	Admissions	Deaths	Years	Admissions	Deaths	Years	Admissions	Deaths
1840	0.40	0	1862	4.68	1.36	1882	0.48	0.05	1901	1.27	0.30
1841	0	0	1863	4.71	1.44	1883	.14	.05	1902	1.02	.17
1842	1.70	.20	1864	8.08	3.21	1884	0	0	1903	.50	.05
1843	.30	0	1865	4.62	1.75	1885	0	0	1904	.32	.05
1844	.12	0	1866	3.37	.70	1886	.23	0	1905	.11	0
1845	.12	0	1867	1.07	.17	1887	.05	0	1906	.17	.02
1846	.55	0	1868	.84	.05	1888	.22	.04	1907	.10	0
1849 [a]	7.22	.87	1869	1.02	.10	1889	.13	0	1908	.19	0
1850	2.23	0	1870	.93	.07	1890	.05	0	1909	.01	0
1851	1.19	.43	1871	.56	.07	1891	.33	.10	1910	.18	.01
1852	1.20	.22	1872	1.65	.25	1892	.05	0	1911	.07	0
1853	1.31	0	1873	1.58	.36	1893	.09	0	1912	.08	0
1854	2.59	0	1874	.16	.04	1894	.04	0	1913	.11	.03
1855	3.74	0	1875	.51	.05	1895	0	0	1914	.09	.01
1856	.21	.07	1876	.22	0	1896	0	0	1915	.05	0
1857	.63	0	1877	.83	.28	1897	0	0	1916	.06	0
1858	1.10	0	1878	.28	0	1898	.66	.16	1917	.21	0
1859	.90	0	1879	.78	.05	1899	3.38	.85	1918	.20	0
1860	0	0	1880	.28	0	1900	1.91	.79	1919	.07	.01
1861	3.36	.15	1881	.24	.05						

[a] No record for the years 1847 and 1848.

The interesting points shown in Chart XLI are two in number: First, the highest admission and death rates since 1840 occurred in 1864 during the Civil War, since which time the general trend of the smallpox admission and death rates in the Army have been downward, except for the period of the Spanish-American War and the Philippine insurrection. Second, prior to the World War the Army had always experienced a sharp increase in smallpox admission and death rates during war periods, whereas during the World War the admission rate was but little higher than for the years immediately preceding, and the death rates for smallpox were essentially the same.

A somewhat more detailed analysis of the admission and death rates during war periods discloses information of importance. The comparative admission and death rates for the Civil War, Spanish-American War and Philippine insurrection, and for the World War are incorporated in Table 55.

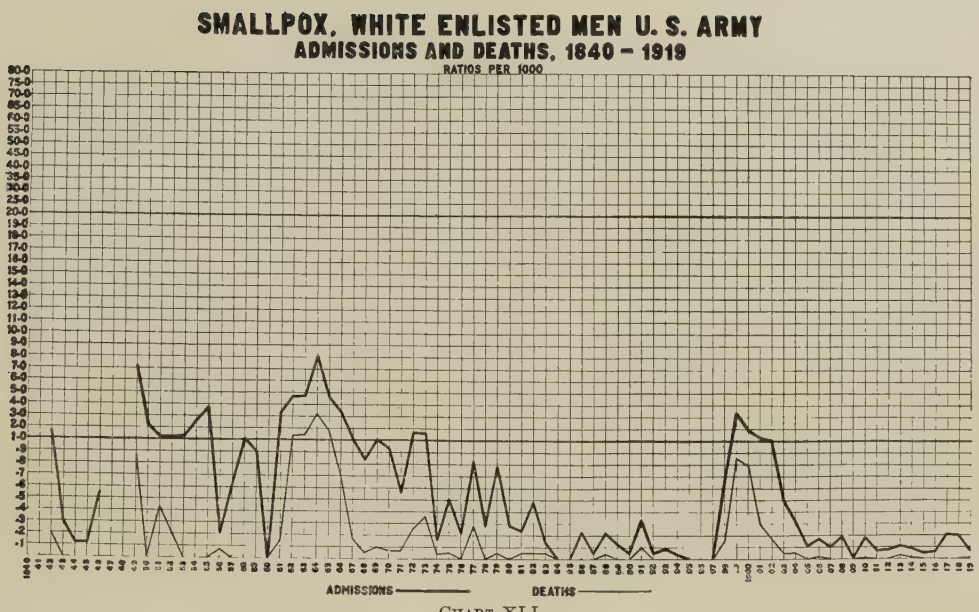


CHART XLI

TABLE 55.—*Smallpox—Admissions and deaths, United States Army in the Civil War, Spanish-American War, and Philippine insurrection, and the World War—Absolute numbers and ratios per 10,000* [a]

	Total mean annual strengths	Admissions		Deaths		Case mortality
		Absolute numbers	Ratios per 10,000	Absolute numbers	Ratios per 10,000 strength	
CIVIL WAR						
White troops May 1, 1861, to June 30, 1866	2,193,427	12,236	55.8	4,417	19.5	36.10
Colored troops July 1, 1863, to June 30, 1866	183,395	6,716	366.2	2,341	122.1	34.85
SPANISH-AMERICAN WAR AND PHILIPPINE INSURRECTION						
Total Army, white and colored, 1898–1901	446,221	825	18.5	258	5.8	31.27
Army in United States, 1898–1901	212,658	126	5.9	4	.2	3.17
Army in Cuba and Porto Rico, 1898–1900	48,686	20	4.1	4	.8	20.00
Army in Philippine Islands, 1898–1901	177,542	674	38.0	249	14.0	36.94
WORLD WAR						
(Apr. 1, 1917, to Dec. 31, 1919)						
Entire Army	4,128,479	853	2.1	14	.03	1.64
Army in United States	2,235,389	780	3.5	1	.005	.13
Army in Europe	1,665,796	24	.1	5	.03	20.83
Army in Philippines [b]	21,451	11	5.1	3	1.4	27.27
Army in other countries [c]	22,620	10	4.4	3	2.1	30.00
Transports	108,033	4	.4	2	.2	50.00
Native troops, Philippine Islands	18,576	23	12.4			
Native troops, Porto Rico	11,831	1	.8			

[a] Source of information: (1) Medical and Surgical History of the War of the Rebellion, Part First, Medical Volume, pp. 640 and 710. (2) Annual reports of the Surgeon General, 1899, 1900, 1901, 1902. (3) Statistical tables, Office of the Surgeon General, 1917–1919.

[b] Includes troops in China.

[c] Not including Hawaii, Panama, and native Hawaiians; including 8,388 officers.

The rates in Table 55 are based on the total of the mean annual strengths for the periods covered. The table shows a marked decrease in rates for each war period as compared with the immediately preceding war period. Based on a rate per 10,000 of strength for each war period, the rates were as follows: Civil War (white troops) 56, Spanish-American War, 19; World War, 2. During the Civil War vaccination as a protective measure was not well carried out for a number of reasons; and while no epidemics occurred, there was a considerable number of sporadic cases.[7] The colored enlisted men incorporated in the Union Army during the Civil War were protected only in small measure by protective vaccination, with the result that the rate per 10,000 of strength for colored enlisted men during the period was 366 as compared with a rate of 56 for white enlisted men in the same army.[7]

An examination into the geographical distribution of the cases of smallpox that occurred during the Spanish-American War and Philippine insurrection is illuminating. Table 55 shows that whereas there was a total of 825 admissions for smallpox during the period referred to, 674 of these cases occurred in troops on duty in the Philippine Islands. The comparative rates per 10,000 of strength were as follows: Total Army, 19; troops on duty in United States, 6; troops on duty in the Philippine Islands, 38. The high rates in the Philippines caused the comparatively high rate for the Army as a whole during this period, and the high rates in the Philippine Islands were due to lack of protection by vaccination and inability to secure a potent vaccine virus for troops on duty in those islands during the first year or more of the occupation.[8]

The first expeditionary forces sent to the Philippine Islands during the Spanish-American War were dispatched hurriedly, and our present knowledge of the keeping qualities of vaccine warrants the statement that many of the individuals when called to active service were vaccinated with an inert virus. On arrival in the Philippines, these forces immediately came in contact with virulent smallpox in epidemic form. It is a matter of record that under the Spanish régime and for a few years subsequent to American occupation more than 40,000 Filipinos died each year of smallpox.[9] American troops gradually came to occupy many small and large towns throughout the islands, with consequent intimate exposure to virulent smallpox. There was the further complication that there were no adequate provisions for the production of the virus in the Philippines, and supplies brought from the United States frequently were not adequately protected by cold storage en route, with the result that they proved to be inert when used. There was the still further complication that even when a potent vaccine became available in Manila itself, no ice was available in which to pack it for shipment to military garrisons in the Provinces. These were the factors that account for the high rate of incidence in the early days of our occupation of the Philippines. The principal factor militating against the protection of our forces, the nonavailablility of potent vaccine

virus, soon was overcome by the establishment of a laboratory, under Government supervision, for the production of the vaccine virus. When and as such a vaccine became available the admission rates immediately dropped, as is shown in Chart XLI. When locally produced vaccine virus became available steps were taken to protect the civil population, with the result that the disease in epidemic form disappeared in the wake of the vaccinating squads. As an example of the striking influence of this protective measure may be cited the fact that the deaths from smallpox in the native population in the Provinces adjacent to Manila were reduced from 6,000 annually to zero and in Manila itself not 1 death from smallpox was recorded for the 7 years prior to 1914.[9]

Subsequent to 1914, as a result of relaxation in administrative control and inefficiency and incompetency on the part of subordinate Filipino health officers charged with the administration of smallpox vaccine, a large unprotected population—young children—came into being. The result was that in 1918 and 1919 the population of the Philippine Islands suffered the greatest smallpox catastrophe of modern times.[9] Incomplete statistics show that more than 60,000 persons died of smallpox during this period and more than 90 per cent of the deaths occurred in unvaccinated children.[10]

Notwithstanding the fact that smallpox in widespread virulent epidemic form attacked the Filipino population during the period of the World War, the military forces (American and Filipino) on duty in the Philippines during the same period were singularly free. In a military force of approximately 40,000 men only 3 deaths from smallpox occurred. Reduced to approximately comparable figures, the statement is justified that the ratio of recorded deaths from smallpox during the epidemic in the native population as compared with that in the military population was as 40 is to 1. The senior writer of this chapter has been informed by those conversant with the situation that, as a matter of fact, it may conservatively be estimated that 100,000 Filipinos died during the course of the 1918–19 epidemic, in which case the comparative ratio would be about 80 to 1, rather than 40 to 1.

The actual results accomplished in the prevention of smallpox in the American military forces during the past 75 years probably can best be expressed in the statement that for every 1 case of smallpox occurring during the World War, 9 occurred during the Spanish-American War and Philippine insurrection and 28 occurred during the Civil War (white enlisted men only). The case fatality rate during the Civil War was 39 per cent; during the Spanish-American War and Philippine insurrection, 31 per cent; and during the World War it dropped to the extraordinarily low figure of 1.6 per cent. (See Table 55.) This low mortality rate is probably accounted for in minor degree by the fact that the type of smallpox prevailing in the United States during the World War was of low virulence; however, the principal factor responsible for the low death rate was the high degree of protection afforded by vaccination.

TABLE 56.—*Smallpox—Admissions and deaths, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919—Absolute numbers and ratios per 1,000*

	Total mean annual strengths	Admissions		Deaths	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
Total officers and enlisted men including native troops	4,128,479	853	0.21	14	0
Total officers and enlisted men American troops	4,092,457	829	.20	14	0
Total officers	206,382	11	.05	1	0
Total enlisted American troops:					
White	3,599,527	612	.17	9	0
Colored	286,548	204	.71	2	.01
Color not stated		2		2	
Total	3,886,075	818	.21	13	0
Total native troops enlisted	36,022	24	.67		
Total Army in the United States including Alaska:					
Officers	124,266	9	.07		
White enlisted	1,965,297	573	.29	1	0
Colored enlisted	145,826	198	1.36		
Total enlisted	2,111,123	771	.37	1	0
Total officers and men	2,235,389	780	.35	1	0
U. S. Army in Europe, excluding Russia:					
Officers	73,728	1	.01	1	.01
White enlisted	1,469,656	16	.01	2	0
Colored enlisted	122,412	5	.04		
Color not stated		2		2	
Total enlisted	1,592,068	23	.01	4	0
Total officers and men	1,665,796	24	.01	5	0
Officers, other countries	8,388	1	.12		
U. S. Army in Philippine Islands:					
White enlisted	16,995	11	.65	3	.18
Colored enlisted	4,456				
Total enlisted	21,451	11	.51	3	.14
U. S. Army in Hawaii:					
White enlisted	16,161				
Colored enlisted	3,319				
Total enlisted	19,480				
U. S. Army in Panama: White enlisted	19,688				
U. S. Army in other countries not stated:					
White enlisted		9		3	
Colored enlisted					
Color not stated					
Total	14,232	9	.63	3	.21
Transports:					
White enlisted	97,498	3	.03		
Colored enlisted	10,535	1	.09	2	.19
Color not stated					
Total	108,033	4	.04	2	.02
Native troops enlisted:					
Philippine Scouts	18,576	23	1.24		
Hawaiians	5,615				
Porto Ricans	11,831	1	.08		

OCCURRENCE DURING THE WORLD WAR

As stated above, smallpox played a very minor part as a cause of sickness and death in the United States Army during the World War. The total mean annual strength of the Army for the period April 1, 1917, to December 31, 1919,

was 4,128,479, and during this period only 853 cases of smallpox were recorded as primary admissions. The admission rate per 1,000 of strength for the period was therefore 0.2, or 2 men in every 10,000. Of those who had the disease only 1.6 per cent died (14 deaths), and the death rate expressed in terms of strength was only 3 deaths in every 1,000,000 men. It will be noted that the expression "primary admissions" is used in referring to the total number of cases. In all the basic tables presented in this chapter the absolute numbers used will be primary admissions unless otherwise specified. Only one disease was used in statistical tabulations, and this was the primary admission. It occasionally happened that an individual admitted for one disease (primary admission) contracted some other disease—for example, smallpox—before release from hospital. This concurrent disease, or complication, was tabulated separately, and the tables of concurrent diseases show that in addition to the primary admissions (853) a total of 126 cases of smallpox were concurrent with other diseases, making a grand total of 979 cases (.24 per 1,000 of strength).

GEOGRAPHICAL DISTRIBUTION

The geographical distribution of smallpox during the World War is shown in Table 56.

Briefly, the facts of interest disclosed by this table are as follows, the admission ratios per 1,000 being converted into ratios per 100,000 of strength that they may be expressed in whole numbers:

	Admissions		Deaths	
	Absolute numbers	Ratios per 100,000	Absolute numbers	Ratios per 100,000
United States (including Alaska), American troops, commissioned and enlisted	780	35	1	0
Europe (excluding Russia), commissioned and enlisted	24	1	5	0
Philippine Islands, American troops, enlisted	11	51	3	14
Philippine Islands, Filipino troops	23	124	0	0
Hawaii, American troops, enlisted	0	0	0	0
Hawaii, Hawaiian troops	0	0	0	0
Porto Rican troops	1	8	0	0
Panama, American, enlisted	0	0	0	0

In order of importance the occurence geographically was the Philippine Islands, United States, Porto Rico, and Europe. As will be explained below, a large proportion of the 780 cases encountered in troops in the United States occurred in nonprotected individuals reporting for duty at mobilization camps in the incubationary stages of the disease.

IN THE UNITED STATES

Mobilization of the military man power of the United States for the World War was accomplished in large mobilization camps and the occurrence of smallpox in 39 of the larger of these camps is tabulated in Table 57. The rates per 1,000 of strength are based on the total mean annual strength for the period.

TABLE 57.—*Smallpox. Admissions by camps of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

Camp	Total mean annual strengths	White admissions		Colored admissions		Total admissions	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
Beauregard, La	20,625	3	0.15	1	2.37	4	0.19
Bowie, Tex	26,193	13	.52			13	.50
Cody, N. Mex	22,636	3	.13			3	.13
Custer, Mich	37,631	12	.33	6	4.43	18	.48
Devens, Mass	47,921	1	.02			1	.02
Dix, N. J	49,786	3	.07	1	.21	4	.08
Dodge, Iowa	39,032	39	1.17	28	4.82	67	1.72
Doniphan, Okla	26,747	32	1.20			32	1.20
Fremont, Calif	15,414	2	.13			2	.13
Funston, Kans	56,222	69	1.38	20	3.24	89	1.58
Gordon, Ga	44,871	7	.18	8	1.17	15	.33
Grant, Ill	49,256	12	.28	14	2.02	26	.53
Greene, N. C	29,710	6	.23	1	.28	7	.24
Greenleaf, Ga	11,959	1	.08			1	.08
Hancock, Ga	37,994	3	.08			3	.08
Jackson, S. C	42,011	5	.14			5	.12
Kearny, Calif	25,472	1	.04			1	.04
Lee, Va	57,635	13	.25	8	1.21	21	.36
Lewis, Wash	47,792	12	.25			12	.25
Logan, Tex	27,734	4	.15	2	1.87	6	.22
McArthur, Tex	25,271	10	.41	1	1.05	11	.44
McClellan, Ala	28,664	3	.11	3	1.41	6	.21
Meade, Md	50,033			2	.25	2	.04
Mills, N. Y	24,197	5	.22	5	3.98	10	.41
Pike, Ark	49,587	6	.15	44	5.05	50	1.01
Sevier, S. C	27,786	9	.34	1	.62	10	.36
Shelby, Miss	30,432	1	.03	6	3.63	7	.23
Sheridan, Ala	26,507	1	.04			1	.04
Sherman, Ohio	42,750	2	.05	6	1.04	8	.19
Taylor, Ky	46,962	19	.45	4	.91	23	.49
Travis, Tex	44,264	19	.51	7	1.06	26	.59
Upton, N. Y	44,871	4	.10	4	.86	8	.18
Wadsworth, S. C	31,809	3	.10			3	.09
Wheeler, Ga	25,726	1	.04	1	.55	2	.08
Others	339			1	2.95	1	2.95
Total (all camps in U. S.)	1,270,068	324	.28	174	1.57	498	.39

Examination of Table 57 shows that in only four of the camps—Camps Dodge, Iowa; Doniphan, Okla; Funston, Kans.; and Pike, Ark.—did the rates of occurrence exceed one case per 1,000 of strength. In only 10 of the remaining 35 camps did the admission rate exceed 0.25 per 1,000 of strength. It is evident, therefore, that smallpox occurred only sporadically during the mobilization of our forces. Furthermore, the historical records of the various camps and hospitals on file in the Surgeon General's Office indicate that a large proportion of the cases arising in the camps occurred in individuals already in the incubationary or acute stage of the disease on arrival at camp and to a considerable extent in individuals soon after the arrival at camp and before protection could have been afforded by vaccination. The following evidence in support of this statement has been epitomized from these historical records:

CAMP BOWIE, TEX.

Of the 13 cases occurring in this camp, no evidence could be adduced that contact played any part. Three recruits reported at camp in the prodromal stages of the disease and one case was contracted through exposure while on furlough.[11]

Camp Devens, Mass.

Only one case occurred at this camp and he contracted the disease prior to induction into active service.[12] The low rate at this camp as well as at all other camps located in the northeastern section of the United States is a reflection of the thoroughness with which protective vaccination is carried out in the civil communities of the States concerned.

Camp Dodge, Iowa

A total of 67 cases occurred at this camp.[13] In six instances the disease occurred in one organization and was attributed to contact. Twenty of the cases were admitted to hospital within a period of 14 days after arrival in camp, most of them having acquired the disease prior to arrival, and in 30 other instances the disease developed within less than a month after arrival. Smallpox is known to have been unduly prevalent in the States—Iowa, Minnesota, and Illinois –from which this camp drew its quota for training, and the prevalence of smallpox at Camp Dodge was merely a reflection of the prevailing conditions in civil communities.

Camp Funston, Kans.

A total of 89 cases occurred at this camp, and the troops in training in this camp were drawn from an area in which smallpox was known to be uncommonly prevalent in the civilian population.[14]

Camp Pike, Ark.

Of the 50 cases arising at this camp, 29 were admitted to hospital within 14 days of their arrival at camp and 1 individual reported at camp in the eruptive stage of the disease.[15] The training quota for this camp was drawn from the States of Alabama, Arkansas, Louisiana, and Mississippi, and the occurrence of smallpox at Camp Pike was a reflection of the undue prevalence of smallpox in some of those States.

Camp Taylor, Ky.

Of the 23 cases at this camp, it is stated that 13 were in the incubationary stage of the disease at the time of arrival at camp.[16]

From what has been said in preceding pages, the inference may be drawn that the greater prevalence of smallpox in some mobilization camps, as compared with others, was attributable to the more extensive prevalence of the disease in certain States or groups of States than in others. In support of this statement a statistical analysis is offered in Table 58.

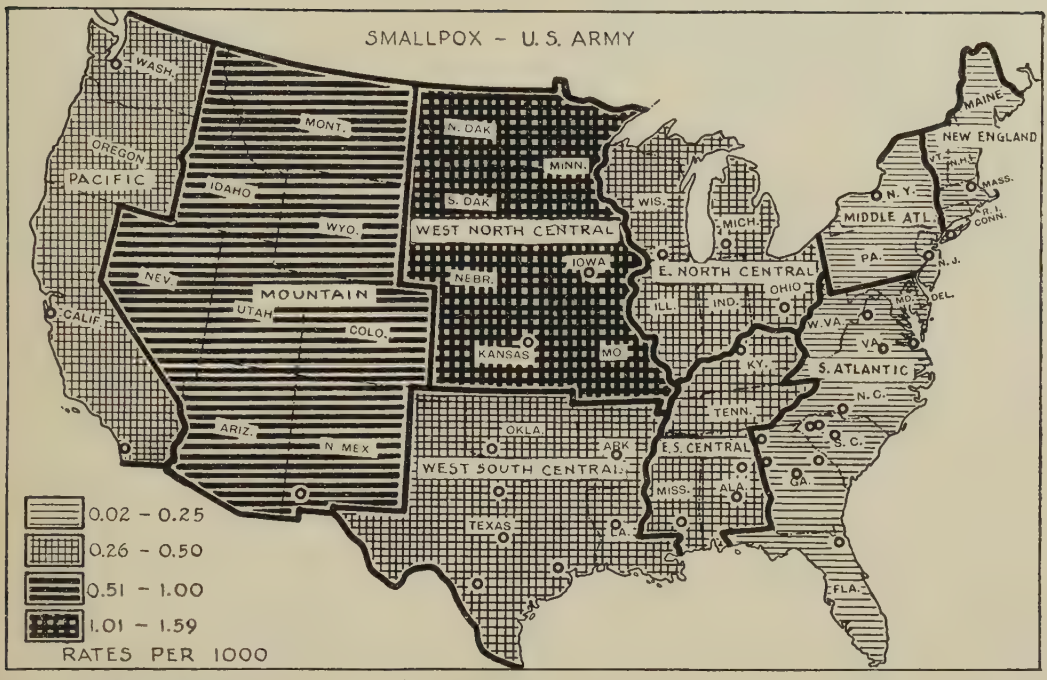
TABLE 58.—*Smallpox. Numbers of admissions and ratios per 1,000 enlisted men (white and colored), United States Army, by States and groups of States, and comparable ratios per 1,000 among the civilian population of these States and groups, April 1, 1917, to December 31, 1919* [a]

States	Military personnel			Civilian population (morbidity rate per 1,000)
	Total mean annual strength	Number of admissions	Morbidity rate per 1,000	
New England group:				
Maine	6,465	0	-------	0.70
New Hampshire	1,911	0	-------	-------
Vermont	5,834	0	-------	.11
Massachusetts	66,538	1	0.02	.01
Rhode Island	5,405	0	-------	-------
Connecticut	1,912	1	.52	.07
Total	88,065	2	.02	.12
Middle Atlantic group:				
New York	155,384	22	.14	.03
New Jersey	114,683	5	.04	.02
Pennsylvania	31,153	0	-------	.05
Total	301,220	27	.09	.04
East North Central group:				
Ohio	58,713	21	.36	1.16
Indiana	20,131	8	.40	1.45
Illinois	65,093	29	.45	.54
Michigan	46,112	21	.46	.85
Wisconsin	8,512	0	-------	.89
Total	198,561	79	.40	.94
West North Central group:				
Minnesota	11,224	4	.36	.94
Iowa	42,495	70	1.65	.99
Missouri	14,402	43	2.99	-------
North Dakota	276	0	-------	.45
South Dakota	410	3	7.32	1.40
Nebraska	6,378	0	-------	-------
Kansas	63,325	100	1.58	2.11
Total	138,510	220	1.59	1.22
South Atlantic group:				
Delaware	3,388	0	-------	-------
Maryland	73,312	3	.04	.13
District of Columbia	20,095	5	.25	.19
Virginia	136,536	28	.21	.45
West Virginia	1,105	0	-------	.90
South Atlantic group—Con.				
North Carolina	35,927	7	0.19	-------
South Carolina	106,902	20	.19	0.12
Georgia	161,205	36	.22	-------
Florida	31,170	1	.03	-------
Total	569,640	100	.18	.39
East South Central group:				
Kentucky	60,254	50	.83	-------
Tennessee	2,921	0	-------	-------
Alabama	62,278	9	.14	.72
Mississippi	34,028	7	.21	1.25
Total	159,481	66	.41	.95
West South Central group:				
Arkansas	53,554	52	.97	.80
Louisiana	29,916	11	.37	.47
Oklahoma	32,949	34	1.03	-------
Texas	269,641	89	.33	-------
Total	386,060	186	.48	.63
Mountain group:				
Montana	1,925	6	3.12	2.03
Idaho	432	1	2.31	-------
Wyoming	4,478	0	-------	1.46
Colorado	7,404	20	2.70	1.26
New Mexico	36,527	7	.19	-------
Arizona	21,978	7	.32	-------
Utah	5,685	0	-------	3.17
Nevada	165	0	-------	-------
Total	78,594	41	.52	1.87
Pacific group:				
Washington	82,243	33	.40	1.38
Oregon	10,452	3	.29	1.27
California	94,357	12	.13	.34
Total	187,052	48	.26	.77

[a] Source of information: (1) Sick and wounded reports made to the Surgeon General, U. S. Army. (2) Public Health Reports—Notifiable Diseases, Prevalence in States, 1917, 1918, 1919. Government Printing Office, Washington, D. C.

The data in Table 58 are assembled by groups of States in conformity with the grouping adopted by the United States Bureau of the Census. It will be noted in the statistics covering the civilian population that certain States have been omitted. The principal reason for this is that such States had not been admitted to the registration area and authoritative figures were not available. It should also be explained that the rate in the civilian population for each group of States is an average of those rates available for the States comprising the group rather than for all States comprising the group; for example, the rates for the New England group are based on the rates for four States rather than six.

Analysis of this table lends adequate support to the statement that the rate of occurrence of smallpox in military personnel in mobilization camps during the World War was dependent on its rate of occurrence in the civilian population in near-by States and was a reflection thereof. This can best be appreciated by inspection of Chart XLII.



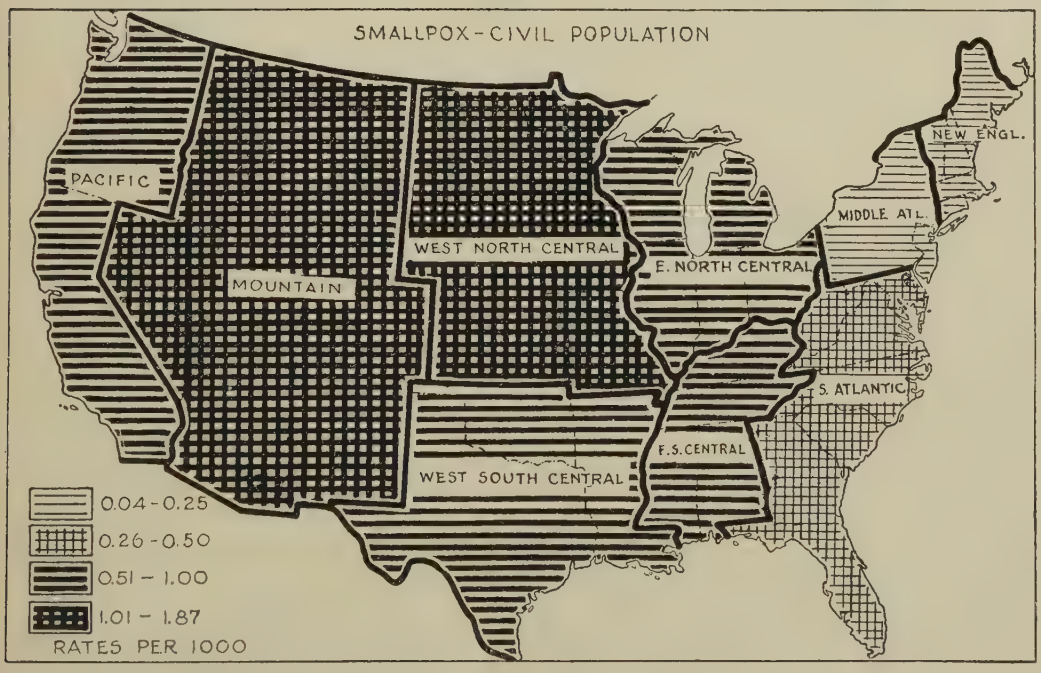


CHART XLII.—Smallpox in the United States Army and civil population, April 1, 1917, to December 31, 1919. Occurrence by groups of States. Ratios per 1,000 of population

Leake and Force,[17] who reviewed the prevalence of smallpox in the United States during recent years (1915–1920), found that the disease is markedly increasing in certain sections. In general, it may be said that the increase is occurring in the southern and central groups of States and in practically all States west of the Mississippi River. In the New England and Middle Atlantic groups the rates are very low and have remained so for years. In the Pacific group, the rates are increasing rapidly. A correct interpretation of this condition presupposes a knowledge of the laws and customs governing preventive vaccination in the United States. There are no Federal laws governing this matter, the formulation and enforcement of protective measures of this nature being left to each State. The result is that in some States the laws are effective and well administered and there is practically no smallpox, whereas in others they are loosely drawn or inefficiently administered, or both, with the inevitable result—increased occurrence of the disease. In New York State, for example, the law provides that vaccination against smallpox shall constitute a condition requisite for school attendance in cities of the first and second class, and for other children residing in the State when smallpox is declared epidemic by the State commissioner of health. The public health organization of the State is a strong one and vaccination is efficiently administered. It is not surprising, therefore, that during the period, April, 1917, to December, 1919, the reported incidence rate for smallpox was only 14 cases in every 100,000 of population. On the contrary, the vaccination laws in the State of Kansas are most ineffective, and it occasions no surprise to learn that the reported rate of incidence for that State for the same period (April, 1917, to December, 1919), was 158 cases in every 100,000 of population. In the State of Indiana, for example, it is lawful for health officers to order compulsory vaccination of school children upon pain of exclusion from school for noncompliance. The Indiana State Board of Health, however, advises its health officers to be very chary in issuing such orders on account of the opposition exhibited by the citizens of the State. The reported smallpox morbidity rate for Indiana for the period under discussion (April, 1917, to December, 1919), was 40 per 100,000 population.[18]

IN EUROPE (RUSSIA EXCEPTED)

During the period, April, 1917, to December, 1919, there were 24 primary admissions for smallpox in the American forces in Europe, with 5 deaths. The admission rate was 1 in every 100,000 of strength. The cases were of sporadic occurrence except for 5 cases arising in January and February, 1919, in Base Hospital No. 103, at Dijon, France.[19] The original of this small group of cases was an enlisted man of Company K, 52d Infantry, admitted to hospital with what at first appeared to be chicken-pox. A correct diagnosis was not arrived at until a short time prior to the death of the individual, when a confluent hemorrhagic eruption appeared. As a result of contact with the original case, a nurse and three attendants developed smallpox. The nurse had the disease in highly virulent form and died; the three enlisted attendants recovered. As soon as the true condition was recognized, all military personnel in Dijon were revaccinated with a fresh "green" vaccine virus obtained from Paris, and no further cases arose. In the interim between admission of the case to

hospital and final diagnosis of smallpox no revaccinations were carried out, and the three individuals who later contracted the disease through exposure had not therefore been revaccinated. The important lesson to be deduced is that in all cases suggestive of a diagnosis of smallpox it is wise to consider them as such, at least administratively, and to revaccinate all persons exposed.

IN THE PHILIPPINE ISLANDS

The comparatively high admission rate in the Philippine Islands, as has been explained in previous pages, coincided with a devastating epidemic of virulent smallpox in the native population of the Philippine Islands. Though 34 cases of smallpox occurred in approximately 40,000 American and Filipino troops in the Philippine Islands, the influence of protective vaccination is evidenced in the fact that only 3 of these cases resulted in death.

IN OTHER COUNTRIES WHERE OUR TROOPS SERVED

No cases occurred in Hawaii. Among the Porto Rican troops, 1 case occurred and the individual recovered. In Panama, there were no cases. In Siberia, 9 cases, with 3 deaths, occurred among our expeditionary forces there.

IN THE ALLIED ARMIES AND IN THE MILITARY FORCES OF GERMANY AND AUSTRO-HUNGARY

An effort was made to secure information as to the occurrence of smallpox in the military forces of all the European nations (Russia excepted) engaged in the World War. Though incomplete, the information obtained is of sufficient importance to warrant its inclusion here.

FRENCH ARMY

During the four years of the war only 28 cases of smallpox occurred in the French Army, and among French colonial troops 44 cases were reported, with 4 deaths.[20] Vaccination was a compulsory measure in the French Army and it is understood that a "green," rather than a "ripe," glycerinated vaccine was used. Vaccines of the "green" type, though containing more pyogenic organisms, are undoubtedly more potent, and this doubtless accounts for the exceptional freedom of the French forces from smallpox.

BRITISH ARMY

British forces serving in France were exceptionally free of smallpox.[21] During 1914 and 1915 no cases were reported; during 1916, 4 cases; 1917, 2 cases; and in 1918, 6 cases, with 3 deaths. Prior to 1914, the British Army was well protected by vaccination. In January, 1916, the Army Council issued instructions authorizing the enlistment of men who refused vaccination ("conscientious objectors"). The promulgation of these instructions resulted in the dissemination of a considerable number of these "conscientious objectors" throughout various commands in the different theaters of war. These nonimmunes created no trouble in France, as all the armies operating on the Western Front were well protected, as was also the case with the population of France

in general. In the Near East, however, conditions were quite different, smallpox prevailed in the civil populations, supplies of potent vaccine were difficult to obtain, and very considerable numbers of nonimmune military personnel were incorporated in the various commands. It is not surprising, therefore, that difficulty was encountered with smallpox. The disease appeared in the forces in Mesopotamia, and gradually spread, with the result that 1,908 cases were reported between December, 1916, and October, 1918. Great difficulty was encountered in stamping out the disease because of the considerable numbers of military nonimmunes, the impossibility of making vaccination compulsory, the widespread prevalence of smallpox in the civil population, and the inability to secure adequate supplies of a potent vaccine virus. As a matter of fact, the epidemic was only finally brought under control by the establishment of a vaccine-producing laboratory on the ground. In two regiments with a combined strength of 1,749 men there were 204 men unprotected by vaccination. In the unprotected group 25 cases of smallpox (123 per 1,000) occurred, with 5 deaths (20 per cent), whereas in the remaining protected group there were only 5 cases (3 per 1,000), with no deaths. During the period March 31, 1918, to March 29, 1919, 1,068 cases were reported in Mesopotamia with the following death rates:[21]

	Admissions	Deaths	Mortality (per cent)
British troops	516	86	17
Indian	552	56	10

The records of protective vaccination in these groups indicate that the admission and death rate in the unprotected group was far greater than in the protected group. The matter is summed up in the following words:[21]

> The lessons taught by the war on the subject of smallpox stand out clearly. If compulsory vaccination is not permitted, and men unprotected from smallpox by vaccination are sent to a war area where the disease is endemic, a sharp epidemic may flare up, as happened in the French Army during 1870–71. It was unfortunate that in Mesopotamia the one great essential in combating smallpox was denied to the medical services, namely, compulsory vaccination. If similar conditions should occur in future campaigns, the authorities concerned should realize how great a source of weakness must be present in the event of a smallpox endemic area becoming a theater of war. Attention should be devoted to the training of all medical officers in the diagnosis of the disease and the operation of vaccination. Further research in lymph suitable for a hot country is required. Careful plans for the proper distribution of lymph are essential, and the medical arrangements of a force will not be complete without adequate means for distributing the lymph in thermos flasks or other suitable containers. If resistance is to be offered against a severe outbreak, well-equipped isolation hospitals with modern and effective methods for disinfection will also be necessary.

BELGIAN ARMY

No cases were reported in the Belgian Army.[22]

ITALIAN ARMY

In the Italian Army 695 cases of smallpox were reported (1915, 79 cases; 1916, 148 cases; 1917, 139 cases; 1918, 329 cases).[23] Military regulations provided for compulsory vaccination. No information is available as to the

thoroughness with which the regulations were complied with nor as to distribution of cases with respect to the vaccinated and the nonvaccinated status of the personnel.

GERMAN ARMY

During the four years of the European war there were reported in the German military forces 434 cases of smallpox, with a case mortality rate of approximately 5 per cent.[5] This speaks well for the thoroughness with which vaccination was carried out in the German Army, as their forces were exposed to smallpox both on the Russian front and in the Balkan States.

AUSTRO-HUNGARIAN ARMY

Vaccination was not effectively carried out in the Austro-Hungarian Army, particularly as regards those forces serving in Galicia; as a consequence 25,000 cases had been reported by the end of 1915, and during 1916 an additional 18,000 cases were reported.[24] Doctor Morawetz, Vienna, who was in charge of a large smallpox hospital during the war, in a personal communication, has furnished the following information relative to smallpox in the Austro-Hungarian Army:[24]

> Smallpox was a rare disease in the army before the war, and was only occasionally seen among civilians in Vienna. Although in the absence of epidemics, vaccination was not strictly compulsory, it was customary among civilians, and a high percentage of immunes were thus created. However, this was not universally true in Galicia, where vaccination was not carried out to the same degree and many persons were susceptible to the disease. During the war, vaccination became careless and many children were not protected. It was compulsory in the army, but as time went on the supply of lymph became inadequate on account of the scarcity of animals, and it was not uncommon to find many men in the service without vaccination scars. There are no statistics available to show occurrence of smallpox, either in the army or in the country as a whole. Such records have been misplaced or destroyed. However, for Vienna, the first case was reported in October, 1914, a soldier returning from the battle fields of Russia, where smallpox was prevalent. This case was followed by three others among soldiers. From that time, there was a rapid increase in the number of cases, and during the last three months of 1914, 112 cases were recorded. During the following year, 1915, 1,566 cases were reported, after which there was a decrease. In 1914, 7.4 per cent of the cases reported were among the military population; in 1915, 4.2 per cent; in 1916, 39.9 per cent; and in 1917, 64 per cent. In the civil population, the occurrence was chiefly among babies or children under the school age. The disease was brought under control by compulsory vaccination; but following the conclusion of hostilities, there was an increase due largely to fugitives from Poland.

RACIAL DISTRIBUTION, AMERICAN TROOPS (WHITE AND COLORED)

The detailed statistics showing prevalence of smallpox in our white and colored enlisted men are in Table 56. The rate for colored enlisted men was considerably higher than for white enlisted men, both in the United States and in Europe; admission rates for the Army as a whole having been 17 cases per 100,000 of strength for white, as compared with 71 per 100,000 for colored enlisted men. Vaccination for the colored population of the United States is not so complete as for the white population, and this accounts for the comparatively high rates in the colored group.

RELATIONSHIP OF SMALLPOX TO LENGTH OF SERVICE AND TO PREVIOUS VACCINATION

In previous pages it has been stated that a large proportion of the smallpox occurring in mobilization camps in the United States was not chargeable to the Army, but was traceable rather to exposure in civil communities just prior to reporting at camps.

Prior to the World War, Army Regulations provided that certain data relative to all cases of smallpox in military personnel were to be reported to the Surgeon General of the Army, and these regulations were continued in force during the war. The data to be reported are shown on the following form:

INFORMATION DESIRED BY OFFICE OF THE SURGEON GENERAL IN CASES OF SMALLPOX AND SUSPECTED SMALLPOX

1. Name of patient:
2. Rank and organization:
3. Date of enlistment: Where mustered in:
4. Age:
5. Last station and date of joining present station:
6. Date taken sick: Where:
7. Date admitted to sick report: Where:
   By whom:
8. Has patient been vaccinated against smallpox? If so, give dates and names of places where administered (from records available, consult service record); also the result—i. e., immune reaction, vaccinoid, vaccinia, or unsuccessful. (See F. 81 M. D.: "The immune reaction appears as an areola after 24 hours and disappears in 72 hours. In a case of vaccinoid there is a small pustule which appears and disappears more quickly than in vaccinia. These reactions are evidence of protection. The term "protected" will not be used.)
9. Soldier's statement regarding vaccination, where obtainable:
10. Medical history of present attack (to accompany on regular form):
11. Whether cases of smallpox exist in the post or neighborhood among soldiers or civilians:
12. Diagnosis:
13. Remarks:

Date _____

Station _____

Signed _____

It was possible to analyze 422 of these reports pertaining to the World War, from the viewpoint of the interval between the date of reporting at camps and the appearance of symptoms of smallpox, the following information being obtained:

Interval between date of reporting at camps and appearance of symptoms of smallpox	Number of cases	Per cent of total
Active smallpox on arrival at camp	2	1
1 to 3 days after inoculation	69	16
4 to 14 days after inoculation	82	19
15 to 30 days after inoculation	88	21
1 to 3 months after inoculation	50	12
3 to 12 months after inoculation	93	22
More than 1 year after inoculation	6	1
Time interval unknown	32	8

In this analysis of the special reports on smallpox it will be noted that two of the cases arrived at camp with smallpox. These special reports, however, cover only about one-half of the cases that occurred during the World War, and unfortunately include only a small percentage of such cases, for the historical records of the various camps of mobilization indicate that a very considerable number of men had smallpox on arrival at camp. Thus at Jefferson Barracks there were 4; Camp Pike, 14; Columbus Barracks, 5; Camp Funston, 9; Camp Dodge, 14; Camp Lee, 31; Camp Taylor, 13; Camp Sherman, 2; Camp Travis, 3; Fort Thomas, 15; Camp Upton, 2.

Since the incubation period of smallpox is usually 14 days, and 153, or 36 per cent, of the above group of 422 cases came down with smallpox within 14 days of their arrival at mobilization camps, it may be stated very definitely that somewhat more than one-third of the individuals of the group contracted the disease prior to their entry into the service. Only six individuals (1 per cent of the total in this group) with more than one year of service contracted smallpox. More adequate protection, as a result of revaccinations, accounts for the freedom from smallpox of the group of individuals with service in excess of one year. Three per cent of the cases occurred in Medical Department personnel nursing cases of smallpox.

PREVENTIVE MEASURES

VACCINATION

Needless to say, the principal, and for practical purposes the only, measure on which the United States Army has relied for the prevention of smallpox is vaccination.

For many years prior to the World War a considerable number of manufacturers of biological products were engaged in the manufacture of vaccine virus, the methods of manufacture being regulated by and under the supervision of the United States Public Health Service. The United States Army has never produced its vaccine virus, but has obtained all such products from firms accredited by the United States Public Health Service.

The following regulations governed the administration of vaccine virus to military personnel during the World War: [25]

34. *Smallpox.*—Any case of smallpox occurring among persons subject to military control will be isolated, and contacts not protected by recent successful vaccination will be revaccinated.

35. *Vaccination.*—Vaccination being recognized as an effective means of preventing smallpox, all recruits upon enlistment and all soldiers upon reenlistment will be vaccinated. When the first vaccination of a recruit is ineffective, it will be repeated at the end of eight days.

All the personnel of a military command, station, or transport, including civilians connected therewith, will be vaccinated when in the opinion of the medical officers responsible for sanitation it is necessary as a means of protection against smallpox. Civilians refusing to be vaccinated when so directed by proper authority may be excluded from the military reservation or station.

Officers should be vaccinated at least once in a period of seven years. Troops under orders to perform overseas journeys or field service will be inspected by the responsible medical officer with respect to their protection against smallpox, and those who in his opinion require it will be vaccinated.

Technique.—The skin of the selected site must be clean. Washing with warm water, followed by alcohol, is usually sufficient, the alcohol being permitted to evaporate before proceeding. Scrubbing with soap and water is necessary for a dirty skin, but needless irritation of the skin is to be avoided.

The procedure, described as follows, is preferable to "scarification," which will no longer be used:

Incision is the method of choice, and should be made with the point of a sterile needle, producing a "scratch." A sterile scalpel may be used, but is more likely to cause bleeding. The incision or scratch should preferably not draw blood. There should be at least two incisions, three-quarters of an inch long and one inch apart; after exposure to smallpox four incisions will be made. The virus is then placed upon the abraded surface and gently rubbed in, unnecessary irritation being avoided.

The wound is allowed to dry thoroughly and can be left without dressing, though several layers of gauze may be applied with adhesive plaster. Any dressing that retains heat and moisture is bad. Shields will no longer be issued.

A number of different methods of administering vaccine virus were subjected to trial by individual medical officers during the World War, the purpose being to develop a more satisfactory technique, to increase the percentage of positive reactions, and to reduce complicating pyogenic infections.

Two of the most promising methods subjected to trial and results obtained are summarized below.

De Lanney, [26] at Fort Crook, Nebr., reported as follows on a multiple puncture technique used by him in vaccinating 508 soldiers.

I have maintained for a number of years that the American method of vaccination was defective in its technique because of the variety of local results, some of which are very severe. Nor could they all be due to individual susceptibility, because bad arms often occurred in those previously vaccinated; neither could they be blamed to the operator because, no matter how careful he was, bad arms were sure to follow. Shields and protectors were often to blame, but bad arms would occur where nothing in the way of protection had been used. What, then, was the cause of those large, sloughing, painful sores with their necrotic cores and sharply defined edges, which later filled up with redundant granulation and still later became glazed over instead of covered with normal epithelium?

During a smallpox epidemic, I had, as city physician to an industrial city, to have about 4,000 laborers vaccinated. The best virus procurable was used and the strictest precaution was practiced, but, in spite of all, a large number of very sore arms developed, with resultant suffering and loss of time to laboring men who could least afford it.

It was noticed that a large number of men of foreign birth had well-formed scars on their arms, and it was learned from them that they nearly all had been vaccinated from scabs removed from another person's arm, as is still the practice in some communities. It was also noticed that when "scab vaccination" had been used, a larger number of places on the arms had been vaccinated, often as many as five or six to each arm. The question then came up: Does not the number of vaccination incisions play an important part in determining the severity of the local reaction? Following these observations, I then proceeded to experiment with multiple vaccination, but the epidemic having been controlled and nearly every one being vaccinated, no large number of unvaccinated could be gotten together for vaccination, observation, and tabulation of results; but from the few that we were able to observe it seemed that the reaction was very much less severe, and that fewer sore arms resulted from the multiple vaccination than in the single ones.

During the mobilization of the National Guard in 1916, I tried again to confirm what had then become a conviction, but the hurry, incident to rapid mobilization, did not permit of statistical report.

In the February 10, 1917, *British Medical Journal*, Capt. H. W. Hill, D. P. H., described a method of vaccination by the subdermal method, and an opportunity to try it out came when 520 truck company personnel came to Fort Crook, to be equipped and prepared for

oversea service. I then had an opportunity to try out the speed with which this method could be used, an essential point when a large number has to be vaccinated, also the percentage of primary and secondary "takes" and the results, both local and systemic. These results are tabulated below, and justified statistically our previous conviction, that multiple affords far less local reaction than single vaccination and that the diffusion of the area of inflammatory reaction prevents local death of tissue.

Number of men vaccinated	Not previously vaccinated	Previously vaccinated	Number of men vaccinated	Not previously vaccinated	Previously vaccinated
508	116	387	Successful, per cent	85	28
Sucessful	99	109	Unsuccessful, per cent	15	72
Unsuccessful	17	278	Number of dressings required	1	0
Had smallpox	3	2			

The time actually consumed in vaccinating each man was about 15 seconds; there was no time lost in waiting for arms to dry, no after treatment, and in no case was any man excused from duty for more than three days. The method was practically that described by Hill, which I here copy:

(1) The sleeve is rolled up. (2) Orderly 1 washes the arm with soap and water. (3) Orderly 2 washes the arm with rectified spirit. (4) Orderly 3 washes the arm with ether. (5) Orderly 4 breaks the capillary tube of glycerinized vaccine, and sets the rubber bulb or other method of expelling contents, handing it to orderly 5. (6) Orderly 5 expels the vaccine at three or four points on the arm in a triangle or square having not less than 2 inches between the points. (7) Orderly 6 sterilizes an ordinary sewing needle, and hands it to the medical officer. (8) Medicial officer punctures the arm through the drops of vaccine; six tiny punctures, drawing no blood, are made through each drop, each set of six occupying a space of not more than one-sixth inch square; the needle is held almost parallel to the surface; not over one one-thousandth of an inch enters the epithelial layer, a peculiar little "snick" being felt as the needle goes in. (9) Orderly 7 wipes the vaccine. (10) The sleeve is pulled down.

The only difference in the technique I used was, that all the needles were mounted on a handle, either a hemostat or pushed into penholders, to facilitate handling. This was found a great help, for when the needle was held in the fingers alone they became very tired and the needle hard to hold.

Of the 508 men vaccinated, not one had a bad arm. There was redness and swelling, differing in degree with each case, but no suppuration or large scabs or large area of necrosis. One case had to be dressed once because of multipustular vaccinia around the points of vaccination. These pustules resembled confluent smallpox, and covered the outer surface of about half the arm, but they soon dried without bad results. In previously vaccinated cases a typical local reaction resembling a von Pirquet reaction appeared at the side of puncture, usually accompanied by itching which subsided in a few hours; this was not an indication that the vaccination was or was not going to "take."

That which is hard to explain is the great variation in the number of successful points of vaccination in different arms; in some cases all four took, in others three, two, or one—this in both primary and secondary cases. It was noticed, however, that the relative number increased in the unvaccinated, while in those with only one "take" it was always a very weak "pock," with very little systemic reaction, as though the individual had a relative high degree of immunity.

The vaccinial "pocks" were typically umbilicated, and dried up in 15 to 20 days in the form of hard black buttons which readily dropped off, leaving a typically vaccinial scar.

* * * * * * *

It would seem from observation of this series that the method described by Hill has many advantages: (1) It protects the arm from external infection, for as soon as the arm is wiped off the punctures are practically sealed; this also obviates the necessity of waiting for the arm to dry or to be dressed. (2) The numerous vaccination points diffuse the area of inflammation over a large surface, thus preventing the formation of a necrotic center, as in the single method, at the same time increasing the percentage of "takes." (3) It is painless and

bloodless. (4) It is rapid enough for any requirement. The saving in suffering, time, bandages, and dressing by this method will be appreciated by those who have had an opportunity to compare this with other methods now used, or who have had to spend whole mornings dressing suppurating arms.

The puncture method of vaccination used by De Lanney and described by Hill[27] was tested on 500 individuals at the Army Medical School, Washington, D. C., during the fall of 1917, and the medical officers making the test were very favorably impressed with the results obtained.[28] The principal advantages were that the vaccination could be more expeditiously done than by the method of linear incision (routine Army method) and the further fact that no dressings or after treatment of any nature were necessary.

The intradermal method of vaccination gave most excellent results as carried out by Wright,[29] at Camp Upton, N. Y. He reported on this method, in part, as follows:

Importance of successful vaccination.—To-day the importance of the successful vaccination and revaccination of troops is appreciated by the medical officers of all armies. In the 367th Infantry, with which regiment I am serving, the regimental medical officers found large numbers of men on whom repeated revaccinations, and in many cases primary vaccinations, by the prescribed incision method gave negative results. The question immediately arose as to whether or not these men were immune to smallpox. According to their histories, very few of them had ever had smallpox, while arm examinations for vaccination scars showed that the majority of them had been successfully vaccinated in civil life—in most cases from 10 to 15 years previously. Some were found who had never been successfully vaccinated against smallpox and had never been through an atttack of the disease. Therefore, it seemed reasonably clear that most of them were not immune, and that those who were immune possessed only partial immunity. At the same time it was evident that their failure to give "takes" was not due to the virus used, because with it we were daily getting a large number of "takes" on other men. Then it occurred to me that intracutaneous injections of vaccine virus might prove to be a more satisfactory method of virus transference than the one that we were using; therefore it was for the purpose of reducing to a minimum the number of unsuccessful vaccinations in the regiment that this work was undertaken.

The method used was as follows: Virus treated with a glycerol-phenol solution was used. The composition of the glycerol-phenol solution was: Phenol (carbolic acid), 1 part; glycerin, 49 parts; and water, 50 parts The virus was diluted with equal parts of sterile distilled water immediately before using, although in a few of the first cases undiluted virus was used. Dilution of the virus was made solely to avoid waste, because I soon discovered that the diluted virus gave just as good results as the undiluted; and sterile distilled water was used for dilution instead of glycerin because it was feared that further dilution with glycerin might cause too much attenuation of the virus. One-tenth cubic centimeter of the diluted virus was injected intradermally by means of a sterile tuberculin syringe and a relatively fine needle, which was also sterile. I used needles size 26 according to the English standard wire gauge No. 189. The site of injection was the skin area covering the insertion of the deltoid muscle. In some of the cases only one insertion was made, but in most of the cases two injections were made, one being separated from the other by a distance of about 1 inch. Two injections are preferred because of the larger area of vesicle formation that results, thereby affording one a better sense of protection, if not actual protection. Control vaccinations by the incision method, as described above, were made on all men vaccinated by the intradermal method; they were made on the same arm, on the same day, and the same virus was used in the two methods. Control injections of the virus-free glycerol-phenol solution, of exactly the same percentage composition as the fluid medium in which the virus was preserved and as shown above, were made on 60 of the men who volunteered. Two-tenths cubic centimeter of this solution was used for each injection, which was also made intradermally.

Results.—Intradermal vaccinations and controls by the incision method were carried out on a total of 227 men. All of these men during the preceding four months had been

unsuccessfully vaccinated by the incision method a number of times, the number varying from two to eight. "Takes" were obtained in 160, or 70.48 per cent of the cases by the intradermal method, whereas "takes" were obtained in only 19, or 8.3 per cent of the same cases by the incision method. All of the 19 cases that showed a "take" by the incision method also showed a "take" by the intradermal method. There were 67 cases that failed to show a "take" by the intradermal method; in all but 4 of these cases, however, the vaccination site showed either an "immunity reaction" or "vaccinoid." The "immunity reaction" occurred in most instances. The 208 cases that did not give a "take" by the incision method exhibited "immunity reactions" and "vaccinoids" in but few instances.

In Table 1 the number of unsuccessful vaccinations by the incision method during the past four months is detailed as well as the results obtained by myself with both methods.

TABLE 1.—*Unsuccessful vaccinations by incision method, and results with incision and intradermal methods*

Number of times unsuccessfully vaccinated in Army	Total number vaccinated	"Takes," intradermal method	"Takes," incision method	Unsuccessful intradermal method	Unsuccessful incision method
1	6	6	0	0	6
2	34	23	2	11	32
3	68	51	8	17	60
4	44	31	3	13	41
5	44	29	3	15	41
6	17	12	1	5	16
7	12	7	1	5	11
8	2	1	1	1	1
Total	227	160	19	67	208

Table 2 shows the results obtained in the case of men who had never been successfully vaccinated in their lives, as compared with the results obtained on men who had been successfully vaccinated at some time prior to their entry into the military service.

TABLE 2.—*Results according to success of previous vaccinations*

	Total	Intradermal "takes"	Incision "takes"	Intradermal unsuccessful	Incision unsuccessful
Men never successfully vaccinated before	50	44	9	8	43
Men successfully vaccinated before	175	116	10	59	165

Of the 8 men who had never been successfully vaccinated, and whose results by the intradermal method were unsuccessful, it was found by inquiry into their histories that 7 had had smallpox, 3 of them having had it five years before, 1 one year before, 1 four years before, 1 eight years before, and 1 eighteen years before. Of the 59 unsuccessful cases by the incision method in this same group, a history of smallpox was obtained in only seven instances.

The course of the eruption as it occurs in primary vaccination by the intradermal method is similar in every way to the course as it occurs by all other methods except for the arrangement of the vesicles, which form a circle around the site of virus deposition. The vesicles appear, as a rule, on the sixth day and become pustules on the seventh or eighth day. The vesicles are multicolor. The center of the circle of vesicles is depressed and shows early scab formation. On the eighth or ninth day the circle reaches its maximum diameter, at which time it measures from 0.5 to 1.4 centimeters. After the ninth or tenth day the vesicles begin to dry up, and at the end of from 12 to 14 days the vaccinated area is marked by a dark brown scab that is sharply circular in outline. This scab falls off in from 18 to 24 days and leaves a sharply circumscribed reddish, circular depressed scar, which may or may not show foveation.

In revaccination "takes" by the intradermal method the vesicles become pustules on the sixth or seventh day, and the size of the circle of vesicles is smaller—their maximum diameters measuring from 0.4 to 0.9 centimeter—than the size circles obtained in the primary vaccination cases.

One circle of vesicles surrounds each site of virus injection.

It is seen that the circular arrangement of the vesicles around the site of virus injection is a constant and characteristic feature of the method, and is the only difference to be noted. The virus produced evidence of its activity by vesicle formation only at points where the skin layers were but slightly separated, which explains the circular arrangement of the vesicles; the actual site of virus deposition is marked by the dark depressed central scab, which is due to the local necrosis produced by the mechanical and chemical injury to the skin at that point.

In none of these cases did any infection occur, and the local reactions in the severest cases were relatively mild as compared with the severe reactions that so often follow vaccination by the incision method.

In the cases of primary vaccination with no history of smallpox, the circle of vesicles was the same size in practically all of the cases, measuring approximately 1 centimeter in diameter. In the cases with a history of smallpox, and also in the revaccination cases, the size of the circle or area of vesiculation varied in a most remarkable way according to the time that had elapsed since the attack of smallpox or the previous vaccination; the more recent the smallpox attack or revaccination, the smaller the circle of vesicles—a result that is not at all surprising because in all of these cases exactly the same amount of virus was introduced, and it seems only reasonable that the size of the area of vesiculation should vary in direct proportion to the immunity against smallpox that the person vaccinated possesses.

With this method it is possible to deposit a definite amount of virus of known strength in each instance; and after having observed that a definite relationship exists between the size of the reaction area and the immunity to smallpox the injected person possesses as shown by his history, I am convinced that intradermal injections of vaccine virus will prove to be a most satisfactory and reliable method for the estimation of the relative immunity of individuals to smallpox, if a sufficient number of observations are made.

The arms of the 60 men on whom control injections of 0.2 cubic centimeter of the glycerol-phenol solution were made showed at the end of 24 hours a small area of erythema, measuring about 2 millimeters in diameter; while at the end of 48 hours all traces had disappeared. It is apparently clear, therefore, that the results obtained were due not to the irritant action of the glycerol-phenol solution on the skin, but rather to the activity of the virus itself, and also that pressure necrosis is not to be considered a factor in their production.

The amount of time required for vaccinating a large number of men by this method is slightly less than the amount required for vaccinating the same number by the incision.

The only disadvantage of the method is the relatively large amount of virus used in comparison with other methods. With 1 cubic centimeter of virus it is possible to vaccinate from 16 to 20 persons, while by most other methods 1 cubic centimeter is a sufficient amount of virus for 40 or 50 vaccinations.

It is evident that Wright attributed a large proportion of failures, or unsuccessful vaccinations, to the routine technique used throughout the Army. There is, however, ample justification for the statement that in so far as the Army as a whole was concerned many of the failures were attributable to other factors, the most important of which doubtless was nonpotent, or weakly potent, virus. The virus routinely used in the Army was a "ripe" glycerinated virus, and whereas such virus will retain its potency for a considerable length of time if kept in cold storage at low temperatures, it loses it more or less rapidly when exposed to the high atmospheric temperatures that prevail in this country during the summer months. Producers of vaccine virus will not guarantee the potency of their glycerinated products if exposed for any length of time to atmospheric temperatures during the hot summer months. The methods of

handling and storing vaccine virus at mobilization camps during the World War were not always ideal; there is no doubt, therefore, that much of the vaccine virus was nonpotent, or only slightly potent, at the time it was actually used. This factor accounts to a considerable extent for the failures obtained.

That the linear incision technique of itself fails to account for a considerable proportion of unsuccessful vaccinations was clearly shown during the course of a small outbreak of smallpox at Dijon, France, in January and February, 1919, referred to above. The technique followed in revaccination was the linear incision method described on page 374. Notwithstanding the fact that all personnel presumably had been protected by vaccination or revaccination prior to departure from the United States, a large percentage of the personnel revaccinated gave positive reactions (vaccinia or vaccinoid). A few hours after revaccination a considerable number of the vaccinated individuals noted a mild inflammatory reaction apparently due to a staphylococcus infection. This subsided and the virus reaction appeared on the fourth to sixth day. Bacteriological examination of the vaccine showed numerous staphylococci, and a laboratory specialist was sent to Paris to inspect the institute from which the vaccine was being obtained. The following pertinent information is abstracted from the report of the inspecting officer:[30]

The smallpox vaccine purchased in France for use by the American Army is prepared at the Institute de Vaccine Animale, 8 Rue Ballu, Paris. * * *

The Institute de Vaccine Animale is over 50 years old and vaccinia virus is its sole product. This institute is at present the only one of its kind in Paris, though there are several other laboratories for the production of the virus in France.

The institute was strikingly clean in all particulars. On the ground floor, in addition to offices and reception room, there is an open court for receiving animals and supplies. This court was in excellent condition. Off to one side from the court was the stable with eight cows. The stables are well lighted by natural and artificial light. The construction was such as to permit complete and thorough flushing of the walls and floor. The animals were clean. They had been inoculated and only the belly of each was used. The inoculated areas of the animals were excellently protected from dust and dirt.

Only animals free from tuberculosis, as proved by rigid tuberculin tests, are brought to the institute. They are also quarantined to assure the absence of other diseases. After collection of the virus, the animals are kept for some days to insure the absence of any other disease, then killed and a careful post-mortem examination made.

The second floor of the institute is the laboratory proper, and here grinding of the pulp is done. The apparatus for this purpose is such as to exclude air during the process. A 50 per cent glycerin is used with such an amount of pulp as to give a final dilution of about 40 per cent glycerin in the virus ready for use. Great reliance is placed on the germicidal properties of glycerin, as proved by tests. As a routine, no bacteriological examinations are made, for the absence of dangerous organisms is accepted, as shown by numerous tests in the past.

The vaccine is ready for use after the following tests: First, the autopsy; second, the test on rabbits for virulence, by inoculation of the entire shaven backs with a dilution of 1 to 1,000 dilution of the virus. This inoculation must give a confluent cowpox; third, tests on the uninoculated human must give 100 per cent of "takes." No attempt is made to rid the vaccine of all but spore-bearing bacteria. It is accepted that bacteria are present in large quantities in the pustules of cowpox, and the director insists that an attempt to ripen the vaccine to such a point would render the vaccine virus itself relatively inactive, and to such a degree as to make the vaccine of little value.

The vaccine, therefore, is not a "ripe virus." On the other hand, inasmuch as glycerin is used, it is not a green virus. It may be described as partially ripened by the addition of glycerin.

The director of the institute lays great stress on the actual results, on the complete absence of accidents in the vaccination of millions of French soldiers and civilians, on the fact that 40 per cent of vaccinations in the French Army during the great war resulted in "takes," and, finally, on the fact that only 10 cases of smallpox occurred during the same period and these of a mild type.

The following figures on the vaccination of 108 individuals at the central Medical Department laboratory are recorded: The figures are small, but these individuals had all been vaccinated within the past two years and none with positive results. Out of these 108 vaccinations, 18.5 per cent gave a normal positive "take" (vaccinia); 26 per cent additional gave a modified positive "take" (vaccinoid).

Vaccination against smallpox as practiced in the United States Army during the World War was highly successful as a preventive measure, as has been pointed out in preceding pages.

We should not be content, however, with the extraordinarily good results obtained but should strive rather to eliminate the disease altogether. In so far as the military service is concerned an approach to this ideal is contingent primarily on two factors: The development of a vaccine virus that will retain its potency for a considerable length of time after exposure to continuously high atmospheric temperature, and perfection of a vaccination techinque that will assure a higher percentage of positive results.

DISCHARGES FOR DISABILITY RESULTING FROM VACCINATION

The basic tables in the statistical volume of this history (Vol. XV, Part II, Table 50, p. 166) indicate that four men were discharged as a result of vaccination against smallpox. The clinical records of these cases have been reviewed and the following pertinent information is made of record to prevent misrepresentation. Of the four individuals presumably discharged on account of disability resulting from vaccination, one was discharged in Europe and three in the United States. One of the four cases was complicated by erysipelas, the end result of which was a peripheral nerve paralysis, and it was for the latter condition that discharge was effected. Two other cases tabulated as being discharged as a result of vaccination were actually discharged for defects that had existed prior to their enlistment and their vaccination had no bearing. The reason for the discharge of the fourth and last case was not made a matter of record.

GENERAL MEASURES

No special hospitals were provided for the care of smallpox cases. These cases were segregated in special wards or separate rooms in the sections of hospitals allotted for the care of acute infectious diseases. Medical personnel (attendants and nurses) caring for such cases were vaccinated at frequent intervals.

On the occurrence of a case of smallpox in a command, regulations provided for immediate vaccination of the command or such parts of it as might be considered necessary by the medical authorities. Revaccination of large groups and the establishment of a so-called working quarantine (confinement to the limits of the area occupied by the group for a period of 14 days) occasionally were practiced when secondary cases arose.

Usually, however, the command had been vaccinated recently, and the cases were of sporadic occurrence without secondary infection. Under such conditions no attention was paid to the matter except revaccination of contacts who recently had not been vaccinated successfully.

Individuals with smallpox were held in isolation until scaling was complete. The average duration of hospitalization of cases of smallpox during the World War was 29 days.

ETIOLOGY

No contributions were made to the elucidation of the etiology of smallpox by Army medical investigators during the World War.

SYMPTOMS

In general, the cases occurring in the United States were mild, in Siberia the infections were usually severe (hemorrhagic and confluent types), and in the Philippines and in France the disease was more severe than in the United States, but not so severe as in Siberia. Of 236 cases concerning which clinical histories are available for study, 166 (70 per cent) were admitted to hospital after the eruption was established. In a few instances patients with headache and fever remained in barracks for several days before smallpox was suspected. Headache was recorded in practically all cases. In 19 instances the records show that at no time did the patient feel ill. Backache was recorded in 42 per cent, and pains in the bones and joints in 33 per cent. Chills were noted in 32 per cent, nausea and vomiting in 21 per cent, and vertigo in 8 per cent. Abdominal pains were complained of in 22 cases (7 per cent), and in 2 of these the pain was located in the right inguinal region, was accompanied by rigidity of the abdominal muscles, and simulated appendicitis. Chest pains occurred in 3 per cent, and bronchitis frequently was noted. Three cases presented marked nervous symptoms, positive Kernig's sign and Babinski's reflex, stiffness of the neck muscles, diplopia, and convulsions. These cases so strongly simulated meningitis that lumbar puncture was performed. Pharyngitis was present in 91 cases (27 per cent).

In but two cases was a prodromal rash noted. This was a morbilliform eruption simulating measles. Distribution of the smallpox rash was that usually seen; i. e., more commonly on exposed surfaces of the body, especially the forehead, palms of the hands, and soles of the feet. The usual induration or "shotty" feel to the papules was recorded in nearly all cases. Scarring was noted in but one case, which occurred in Siberia.

Elevation of temperature was not of constant occurrence. A review of 139 clinical histories shows the temperature during the first week in hospital to have been afebrile in 50 cases (36 per cent); it ranged between 99° F. and 100° F. in 28 (20 per cent), and exceeded 100° F. in 61 cases (44 per cent).

In 87 cases, in which the eruption was more or less fully developed on admission to the hospital, 6 cases were in the macular; 4, maculopapular; 28, papular; 15, papulovesicular; 10, vesicular; 15, vesiculopustular; 22, pustular stage. It will be seen from the above statements that patients were admitted to hospital during all stages of the disease except incrustation. This apparent delay in sending cases to hospital was due principally to the fact that

many arrived in camp in the eruptive stage. This was not confined to camps in any one locality, but was common throughout the United States.

Secondary rise of temperature was practically always absent. Itching frequently was noted and often manifested itself early in the course of the disease. Albumin and casts in the urine were of frequent occurrence but evidently cleared up, as a diagnosis of nephritis was but rarely made.

The following extracts from clinical histories serve to illustrate some of the more important phases of the disease.[31]

A. H. R. (white), Pvt., Company 1, V. T. S., Camp Lee, Va. Length of service, three months. Vaccinated three times unsuccessfully in July and August, 1918. November 1, 1918, without prodromal symptoms, the eruption appeared on the forehead. Lesions so few in number that it was not until they became scattered all over the body, on November 5, that the patient was sent to hospital. Even then he did not feel ill. Temperature and pulse were normal during the evolution and decline of the eruption. Diagnosis: Smallpox. On November 25, headache, backache, slight cough, and elevation of temperature were noted. Following these prodromes an eruption appeared which was diagnosed as chicken pox. Neither disease was severe and the patient was returned to duty after 41 days in hospital.

G. K. (white), Pvt., B. H., Camp Dodge, Iowa. Length of service, three months. Successfully vaccinated February 28, 1918. On duty in isolation ward with smallpox cases. March 18, 1918, with prodromes, an eruption appeared on face, body, and extremities, thickest on forehead. When entered on sick report two days later (March 20) the eruption was described as "a number of small pustules on indurated bases." Temperature 104.4° F., but returned to normal on March 22, and 19 days after admission, desiccation being complete, the patient was discharged from the hospital to resume his duties as attendant in the smallpox ward.

A. L. H. (white), recruit unassigned, 163 D. B., Camp Dodge, Iowa. Length of service, one day. Never vaccinated. Several days before coming to camp the patient noticed an eruption on the forehead. He did not feel sick at the time. Smallpox was present in his home town. He was admitted to hospital on the day of his arrival in camp, May 28, 1918, because of a pustular eruption all over his body. He did not feel sick. On June 3 the pustules were dry and scaling had commenced. By June 8 scaling was complete, and the patient returned to duty on the 10th without any elevation of temperature during his stay in hospital.

C. R. (colored), recruit unassigned, Camp Lee, Va. Length of service, one day. No record of previous vaccination. There was one case of smallpox in his home town at the time of his departure. He was taken sick April 10, 1918, while at home, with a severe headache and backache. There was a history of some fever, in bed four days, sore throat, and a few "bumps" on his face, April 15. He arrived at camp April 17, and was admitted to hospital with normal temperature and a discrete, shotlike, pustular eruption over the face, chest, abdomen, back, arms, and legs. There were a few pustules in the palms of hand and on the soles of feet; also slight umbilication. The eruption was diagnosed as smallpox, and the patient was discharged from hospital after 25 days.

The case histories summarized above are typical of many cases occuring in the United States. One relates to a patient repeatedly vaccinated, with negative results; another to a patient recently successfully vaccinated; the third to a patient who had never been vaccinated; and the fourth to a patient concerning whom there was no record of vaccination status. The first case shows both smallpox and chicken-pox, the disease which is most commonly confused with mild smallpox. In the second case, the question might arise as to whether the case was one of a generalized vaccinia. The belief held by many observers is that generalized vaccinia is a rare disease. The fact that many cases came into camp with active lesions of smallpox and others gave a

history of contact while at home and arrived in camp within the incubation period, throws the weight of evidence in favor of a diagnosis of mild smallpox rather than vaccinia. This was the consensus of opinion among medical officers stationed in the larger hospitals. The mild character of the disease is evidenced by the fact that 22 per cent of the cases were diagnosed varioloid.

DIAGNOSIS

The diagnosis of smallpox is neither simple nor certain prior to the appearance of the eruption. Even then it may offer considerable difficulty if the number of lesions is small. In mild cases, occurring sporadically, the difficulty is increased. This was the experience of the Army during the World War. With universal vaccination in effect, the cases generally were mild, as is shown by the very low case-fatality rate. In but few instances, for example, at Dijon, was it possible to trace the source of infection to persons in the military service, and it but seldom was feasible personally to verify histories of exposure to civilian contacts. The general symptom-complex of a more or less sudden onset, generalized pains, headache, backache, chills, fever, nausea, and vomiting, is not peculiar to smallpox. Most of the eruptive diseases, as well as influenza, present such signs and symptoms in varying degrees of intensity. It was a matter of differential diagnosis and each stage, from the prodromal to the well-marked pustular or scab stage, offered new difficulties. During the prodromal stage the following symptoms were most common, and in the order named: Headache, backache, pains in bones and joints, fever, chills, nausea and vomiting, vertigo, and chest pains. This syndrome necessitated consideration of a diagnosis of influenza, meningitis, and the pneumonias. The differential diagnosis between smallpox and influenza was difficult and sometimes impossible until appearance of the eruption. If no eruption was present by the fourth day, a diagnosis of influenza was considered safe. There were 30 cases in which a tentative diagnosis of influenza was later changed to smallpox. In several instances the resemblance to meningitis led to lumbar puncture. Pneumonia and bronchitis were not uncommon complications, especially among severe cases; pneumonia was reported in five of the more severe cases. These cases were admitted to hospital as pneumonia and the diagnosis of smallpox subsequently was made. In such instances there is a question whether the pneumonia was a complication or whether smallpox was merely a concurrent disease. The clinical records of World War cases do not indicate that typhus or the typhoid fevers caused any particular concern in differentiation from smallpox, though several cases were under observation for typhoid fever over a period of several days before the final diagnosis of smallpox was made.

Since the prodromal rash may be either morbilliform or scarlatinaform, measles, German measles, and scarlet fever were of necessity given consideration. There were 6 admissions to hospital with an original diagnosis of measles, 1 of German measles, and 5 of scarlet fever in which the diagnosis was changed to smallpox after further observation.

Measles was of very common occurrence, and it is not surprising that some confusion was encountered in differentiating it from smallpox. There were 5 cases of smallpox in which measles was diagnosed as a concurrent disease and 6

of measles where an additional diagnosis of smallpox was made. There were 8 cases, with 1 death, in which scarlet fever was a concurrent disease. The case in which death resulted was one of hemorrhagic smallpox contracted in Siberia. It ended fatally after eight days in hospital.

The angina commonly seen in smallpox occasionally led to the consideration of diphtheria. As a concurrent disease, diphtheria was recorded in one case, and, in addition, the clinical records not uncommonly showed the results of repeated cultural and bacteriological examinations for the Klebs-Loeffler bacilus. Drug rash occasionally presented difficulty in diagnosis. This was especially true for iodide and copaiba rashes. The former drug is in common use in the Army and the records show one case sent to hospital as "drug rash" (iodide) in which the final diagnosis was smallpox.

During the vesicular and pustular stages differential diagnosis ordinarily offers no great difficulty to persons conversant with smallpox when the rash is typical. But few medical officers in the Army were clinically conversant with smallpox in atypical form as noted during the World War and there was difficulty in diagnosis.

The clinical records show that cases of smallpox in the United States usually were afebrile unless accompanied by some condition other than smallpox that could account for the elevation of temperature. During the vesicular and pustular stages, syphilis and chicken-pox caused the greatest concern in differential diagnosis. The former was common in the Army. Where discrete lesions occurred, irrespective of type, especially when of recent onset and accompanied by fever, there was a tendency to make a presumptive diagnosis of syphilis. The clinical records indicate that not infrequently consultants from the venereal services were called in before a final diagnosis of smallpox was made. The Wassermann test, consultation, study of vaccination status, general signs and symptoms, especially of the skin and mouth, with observation, were the methods used in arriving at a diagnosis. Even after the use of all available methods in large base hospitals, several cases were sent to duty and recorded as smallpox in which doubt is expressed in the records as to the true diagnosis.

It was with chicken-pox, especially, that difficulty was encountered in differential diagnosis. An analysis of 100 clinical records of smallpox cases shows that 47 per cent were admitted to hospital during the vesicular or pustular stage, and that 9 per cent were thought to be chicken-pox. There were two cases of chicken-pox in which smallpox was diagnosed as a concurrent disease and three cases of smallpox in which chicken-pox was recorded as an additional disease. One case was discharged from hospital after 23 days in isolation, during which time both diagnoses had been considered and no decision was reached as to what the real diagnosis was.

COMPLICATIONS AND SEQUELÆ

The complications and sequelæ of smallpox are usually due to secondary pyogenic infection, and are dependent on the severity of the skin lesions. As the type of disease occurring in military personnel was mild, except in Siberia and in the Philippines, it is not surprising that the complications and sequelæ were also mild in character.

Among the diseases recorded as secondary or concurrent diseases were: Erysipelas, carbuncle, furunculosis, abscesses, and impetigo. There were four cases of erysipelas and two of impetigo. One case with multiple abscesses and one with impetigo ended fatally. Eye and ear complications were uncommon.

The most important complications were those of the respiratory tract, which included 12 cases of bronchitis with recovery, 2 of bronchopneumonia with 1 death, and 4 of lobar pneumonia with 1 death.

Of the 780 primary admissions in the United States, only 1 ended fatally, and that case was complicated with scarlet fever.

Among the total primary admissions, 126 complications and associated diseases were recorded, with 8 deaths. The remaining deaths, 6 in number, show no other diagnosis than smallpox or toxemia. There were no cases of tetanus following vaccination or associated with smallpox.

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CHAPTER X

CHICKEN-POX

Chicken-pox is an acute, highly contagious, though benign, disease affecting adults less frequently than children. It is characterized clinically by a mild prodromal stage and a definite skin eruption. Pathologically there are no findings peculiar to this disease.

STATISTICAL CONSIDERATIONS

There were 1,757 primary admissions for chicken-pox for the total Army during the World War (Table 59). Of this number 1,642 were among officers and enlisted men of the American Army and 115 among the native enlisted troops. The highest admission ratio for any troops was for the native enlisted men serving in their own countries. This was 3.19 per 1,000 per annum. Of the various components of the total Army the colored enlisted men ranked second.

Table 59 shows that there were 31,534 days lost from duty on account of chicken-pox, giving a noneffective ratio of 0.02 per 1,000 strength.

As with other epidemic diseases, chicken-pox was far more common in the United States than in Europe. There were 1,208 primary admissions for troops serving in the United States, giving an admission ratio of 0.54 per 1,000 per annum.

The month of January, 1918, marked the peak for many of the epidemic diseases in the Army during the war. This was true for chicken-pox occurring in the United States. The largest number of primary admissions reported for any one month, and the highest admission ratio, was for January, 1918, when there were 146 primary admissions for the total Army, giving an admission ratio of 0.11 per 1,000 strength.

TABLE 59.—*Chicken-pox. Admissions and days lost, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919*

	Total mean annual strengths	Admissions		Days lost	Noneffective ratio per 1,000 strength
		Absolute numbers	Ratios per 1,000 strength		
Total officers and enlisted men, including native troops	4,128,479	1,757	0.43	31,534	0.02
Total officers and enlisted men, American troops	4,092,457	1,642	.40	29,780	.02
Total officers	206,382	66	.32	949	.01
Total American troops:					
White	3,599,527	1,181	.33	21,755	.02
Colored	286,548	359	1.25	6,420	.06
Color not stated		36		656	
Total	3,886,075	1,576	.41	28,831	.02
Total native troops (enlisted)	36,022	115	3.19	1,754	.13
Total Army in the United States, including Alaska:					
Officers	124,266	52	.42	708	.02
White enlisted	1,965,297	942	.48	17,012	.02
Colored enlisted	145,826	214	1.47	3,723	.07
Total enlisted	2,111,123	1,156	.55	20,735	.03
Total officers and men	2,235,389	1,208	.54	21,443	.03

TABLE 59.—*Chicken-pox. Admissions and days lost, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919*—Continued

	Total mean annual strengths	Admissions		Days lost	Noneffective ratio per 1,000 strength
		Absolute numbers	Ratios per 1,000 strength		
United States Army in Europe, excluding Russia:					
Officers	73,728	13	0.18	221	0.01
White enlisted	1,469,656	209	.14	4,256	.01
Colored enlisted	122,412	130	1.06	2,452	.05
Color not stated		36		653	
Total enlisted	1,592,068	375	.24	7,361	.01
Total officers and men	1,665,796	388	.23	7,582	.01
Officers, other countries	8,388	1	.12	20	.01
United States Army in Philippine Islands:					
White enlisted	16,995	8	.47	121	.02
Colored enlisted	4,456	2	.45	25	.02
Total enlisted	21,451	10	.47	146	.02
United States Army in Hawaii:					
White enlisted	16,161	2	.12	60	.01
Colored enlisted	3,319	7	2.11	159	.13
Total enlisted	19,480	9	.46	219	.03
United States Army in Panama:					
White enlisted	19,688				
United States Army in other countries not stated:					
White enlisted	(a)	7	.49	140	.03
Colored enlisted	(a)				
Total	14,232	7	.49	140	.03
Transports:					
White enlisted	97,498	13	.13	166	.00
Colored enlisted	10,535	6	.57	61	.02
Color not stated				3	
Total	108,033	19	.18	230	.01
Native troops enlisted:					
Philippine Scouts	18,576	88	4.74	1,420	.21
Hawaiians	5,615	8	1.42	123	.06
Porto Ricans	11,831	19	1.61	211	.05

[a] Separate strength of white and colored not available.

Chicken-pox was reported from practically all camps, but its occurrence was not of great importance. Camp Gordon, Ga.; Camp Pike, Ark.; Camp Wheeler, Ga.; and Camp Bowie, Tex., contributed the largest number of cases. The admission ratios per 1,000 strength in these camps were, respectively, 0.98, 0.93, 1.55, and 1.45.

Like smallpox, this disease was more common among colored troops than among white. The highest admission ratio in any camp was for the colored troops serving at Camp Custer, Mich. This was 5.90 per 1,000 strength. The average admission ratio for colored troops serving in the camps of the United States was 1.19, while the average for white troops was 0.45. The average for all troops serving in camps in the United States was 0.52 per 1,000 per annum.

SYMPTOMS

The period of incubation of chicken-pox has not been definitely determined; 10 to 15 days seem probable. The disease is not infrequently marked, particularly in adults, by a mild prodromal stage, but it is common for this stage not

to be observed, that which attracts the attention first being the appearance of a skin eruption. This eruption commonly commences on the back and chest, spreading to other portions of the body, and occasionally involves the palms of the hands and soles of the feet. It is commonly seen on the scalp and on the mucous membrane of the mouth and throat. Theoretically, the eruption passes through the stages of macule, papule, vesicle, pustule, and scab. Practically, the papule is the stage first noticed, and in a few hours it becomes a vesicle. The vesicle is usually not umbilicated, and collapses if punctured, and though its contents usually become somewhat turbid, a definite pustular stage is not common, as seen in smallpox. The vesicle dries, becoming indurated, and usually has a black center, the scab then forming. These lesions are superficial, not generally involving the true skin. There is some itching, which usually leads to scratching, with resultant secondary infection, leading to scarring and permanent defects. The temperature is usually not high, and patients, as a rule, are not toxic. The eruption occurs in crops, which develop rapidly. It is possible, therefore, to have several crops on the patient at the same time, ranging from macule to scab. It is generally accepted that the patient remains a source of infection as long as scabs are present.

During the war, much was written on the probable relationship of herpes zoster and varicella. Lowe [1] expressed the belief that epidemic herpes zoster is followed by chicken-pox. With respect to the question of immunity, he held that an attack of chicken-pox usually confers immunity to chicken-pox, and, in like manner, one attack of herpes zoster is rarely followed by another. If herpes zoster and chicken-pox are the results of the same infection, it should be expected that an attack of one would produce immunity to the other. Lowe believed that immunity to chicken-pox does not necessarily produce immunity to herpes zoster, but could find no record of a case of herpes zoster subsequently developing chicken-pox. Goldberg and Francis [2] observed that herpes zoster may occur in the course of chicken-pox. According to these authors, inflammatory conditions of the ganglia may throw some light on the etiology.

COMPLICATIONS AND SEQUELÆ

The cases of chicken-pox reported in the Army during the war were not followed by serious complications. There were no cases of nephritis and but two cases of pneumonia reported among the primary admissions for varicella.

DIAGNOSIS

To the experienced physician, the diagnosis of chicken-pox, as a rule, is not difficult. It is the confusion with smallpox that makes the diagnosis of this disease one of especially great importance. This is particularly true in the Army. The typical smallpox and chicken-pox cases are not ordinarily confused but there are different types of each disease. Severe forms of chicken-pox have been reported and mild forms of smallpox are encountered. It is in this realm that the greatest confusion exists. In chicken-pox the onset is more sudden, the lesions more superficial, and the general symptoms less marked than in smallpox. Progress of the vesicle is more marked in chicken-pox and there is little or no induration around the lesion which is ordinarily present in smallpox, giving the

lesion the characteristic shotty feel. The prodromal stage is more prolonged in smallpox, and, in the presence of an epidemic in the neighborhood, the absence of a well-marked vaccination scar on a patient, with a skin eruption as above outlined, the diagnosis of smallpox would be strongly suggested.

Experience during the war did not contribute any new and important factors in differential diagnosis between chicken-pox and smallpox. Occurrence of both was comparatively slight and no confusion in diagnosis was reported.

PROGNOSIS

Uncomplicated chicken-pox terminates in recovery. The statistical records of the Surgeon General's Office show one death. This was a white enlisted man who died in August, 1918, in the United States. It is most probable that his death was due to an intercurrent disease. The records also show one case discharged from the service on account of disability following chicken-pox. This case, too, was a white enlisted man, and the permanent disability was due to conditions other than chicken-pox.

TREATMENT

There is no specific treatment for chicken-pox. The cases reported during the war were not toxic and were treated symtomatically, attention being paid to local treatment of the skin lesions. In some instances, carbolized vaseline was applied to prevent itching. Patients were informed of the danger of scarring, resulting from secondary infection due to scratching.

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CHAPTER XI

SCARLET FEVER [a]

STATISTICAL CONSIDERATIONS

During the World War, scarlet fever stood forty-fifth on the list of important diseases in the United States Army, based upon the number of primary admissions (11,675) to sick report. From the standpoint of deaths, scarlet fever stood ninth on the list of important diseases, being exceeded by the following diseases in the order named: Influenza, lobar pneumonia, bronchopneumonia, measles, tuberculosis of the lungs, epidemic meningitis, appendicitis, and bronchitis. There were reported 354 deaths from scarlet fever for the total Army during the World War among the primary admissions. The admission ratio per 1,000 strength for the total Army was 2.83 and the death ratio 0.09.

There were 18 cases discharged from the service on account of disability following scarlet fever. These cases were among white enlisted men.

TABLE 60.—*Scarlet fever. Admissions, deaths, discharges for disability, and days lost, by countries, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919, inclusive*

	Total of mean annual strengths	Admissions		Deaths		Discharges for disability		Days lost	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Noneffective ratios per 1,000 strength
Total officers and enlisted men including native troops	4,128,479	11,675	2.83	354	0.09	18	0.00	498,190	0.33
Total officers and enlisted men American troops	4,092,457	11,673	2.85	354	.09	18	0	498,144	.33
Total officers	206,382	222	1.08	4	.02			8,342	.11
Total American troops:									
White	3,599,527	10,993	3.05	338	.09	18	.01	472,967	.36
Colored	286,548	97	.34	2	.01			4,369	.04
Color not stated		361		10				12,466	
Total	3,886,075	11,451	2.95	350	.09	18	0	489,802	.35
Total native troops (enlisted)	36,022	2	.06					46	0
Total Army in the United States including Alaska:									
Officers	124,266	173	1.39	1	.01			6,547	.14
White enlisted	1,965,297	8,778	4.47	265	.13	15	.01	372,267	.52
Colored enlisted	145,826	87	.60	2	.01			3,814	.07
Total enlisted	2,111,123	8,865	4.20	267	.13	15	.01	376,081	.49
Total officers and enlisted men	2,235,389	9,038	4.04	268	.12	15	.01	382,628	.47

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

TABLE 60.—*Scarlet fever. Admissions, deaths, discharges for disability, and days lost, by countries, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919, inclusive*—Continued

	Total of mean annual strengths	Admissions		Deaths		Discharges for disability		Days lost	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Nonefective ratios per 1,000 strength
U. S. Army in Europe, excluding Russia:									
Officers	73,728	46	0.62	3	0.04			1,669	0.06
White enlisted	1,469,656	1,959	1.33	61	.04	3	0	92,352	.17
Colored enlisted	122,412	9	.07					484	.01
Color not stated		356		10				12,372	
Total enlisted	1,592,068	2,324	1.46	71	.04	3	0	105,208	.18
Total officers and enlisted men	1,665,796	2,370	1.42	74	.04	3	0	106,877	.18
Officers—Other countries	8,388	3	.36					126	.04
U. S. Army in Philippine Islands:									
White enlisted	16,995	9	.53	2	.12			259	.04
Colored enlisted	4,456								
Total enlisted	21,451	9	.42	2	.09			259	.03
U. S. Army in Hawaii:									
White enlisted	16,161	12	.74	1	.06			444	.08
Colored enlisted	3,319								
Total enlisted	19,480	12	.62	1	.06			444	.06
U. S. Army in Panama (white enlisted)	19,688	2	.10					46	.01
U. S. Army in other countries and not stated:									
White enlisted	(a)	27		1				1,237	
Colored enlisted	(a)								
Color not stated		5						94	
Total enlisted	14,232	32	2.25	1	.07			1,331	.26
Transports:									
White enlisted	97,498	206	2.11	8	.08			6,362	.18
Colored enlisted	10,535	1	.09					71	.02
Total enlisted	108,033	207	1.92	8	.07			6,433	.16
Native troops enlisted:									
Philippine Scouts	18,576	1	.05					12	0
Hawaiians	5,615	1	.18					34	.02
Porto Ricans	11,831								

[a] Separate strength of white and colored not available.

This disease was much more common among white enlisted men than among any other troops in the American Army, white enlisted men numbering 10,993 primary admissions and colored, 97. Among the former, there were 338 deaths and among the latter, 2 deaths. The admission and death ratios are equally striking in comparison. White enlisted men had an admission ratio of 3.05 and a death ratio of 0.09 per 1,000 strength, as compared with the admission ratio of 0.34 and the death ratio of 0.01 for colored enlisted men. This same difference between the two races is shown by the number of days lost: There were 472,967 days lost from duty among white enlisted men and 4,369 among colored. It has long been known that the occurrence of scarlet fever among the colored is far less than among white people; experience during the World War was in accordance with this. Although scarlet fever

occurs in tropical countries among natives, its occurrence there is of less importance than among white people in temperate zones. The occurrence of this disease among native troops of the American Army during the World War was of no importance from a disability standpoint. Among the 36,022 native enlisted troops, there were 2 cases and no deaths.

When viewed from the standpoint of seasonal prevalence, the occurrence of scarlet fever was greatest during January, February, and March, 1918. Though this was true for some of the other epidemic diseases, namely, epidemic meningitis and mumps, the diseases just mentioned were more common among colored troops, while scarlet fever was more common among white troops. The largest number of primary admissions was reported for the month of March, 1918. The largest number of deaths reported from scarlet fever for any month during the war was also in March, 1918. There were 40 deaths during that month, all of which were among white troops. The seasonal occurrence commencing in October, 1918, and ending in April, 1919, although marked, was to a much less degree than during the preceding year, not only in admissions, but also for deaths. The warmer months of the World War period were marked by a very small occurrence of scarlet fever in the Army.

TABLE 61.—*Scarlet fever. Admissions and deaths, white and colored enlisted men, United States Army, United States and Europe, by months, April 1, 1917, to December 31, 1919*

Month and year	White enlisted men										Colored enlisted men								
	United States					Europe					United States					Europe [a]			
		Admissions		Deaths			Admissions		Deaths			Admissions		Deaths			Admissions	
	Mean strengths	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Mean strengths	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Mean strengths	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Mean strengths	Absolute numbers	Ratios per 1,000 strength
1917																		
April	183,758	115	7.51	5	0.33						4,870		2.46					
May	245,454	150	7.33	8	.39	626					5,826							
June	309,205	170	6.60	2	.08	12,794					5,171							
July	458,817	118	3.09	3	.08	28,821					6,675							
August	562,714	66	1.41	1	.02	50,882					8,519							
September	776,466	97	1.50			70,266	2	0.34			9,409							
October	1,032,244	130	1.51	1	.01	92,139	15	1.95			21,795	2	1.10			935		
November	1,061,422	319	3.61	16	.18	123,429	28	2.72	5	0.49	39,225	3	.92			2,392		
December	1,129,065	631	6.71	16	.17	160,178	122	9.14	6	.45	36,851	5	1.63	1	0.33	5,346		
Total, 1917	479,929	1,796	3.74	52	.11	44,928	167	3.72	11	.24	11,529	11	.95	1	.09	723		
1918																		
January	1,096,434	1,130	12.37	38	.42	193,264	168	10.43	4	.25	50,705	4	.95			8,673	3	4.15
February	1,095,039	1,099	12.04	29	.32	223,130	152	8.17	1	.05	49,955	8	1.92			9,664	1	1.24
March	1,129,223	1,092	11.60	37	.39	283,268	236	10.00	3	.13	54,814	14	3.06			11,541	1	1.04
April	1,168,558	947	9.72	32	.33	388,048	174	5.38	6	.19	59,015	5	1.02			12,667		
May	1,197,757	449	4.50	4	.04	587,240	185	3.78			87,650	6	.82	1	.14	28,279	1	.42
June	1,303,746	134	1.23			796,427	136	2.05	2	.03	89,305	1	.13			33,208		
July	1,328,513	92	.83	3	.03	1,063,192	74	.84	4	.05	124,976	1	.10			47,171	1	.25
August	1,284,247	50	.47			1,266,592	47	.45	1	.01	168,422	2	.14			78,734		
September	1,321,440	46	.42	2	.02	1,527,793	51	.40	5	.04	164,846	1	.07			91,270	1	.13
October	1,343,933	107	.96	10	.09	1,635,321	68	.50	3	.02	182,705	2	.13			138,827		
November	1,255,195	446	4.26	31	.30	1,682,836	74	.53	4	.03	150,587	29	2.31			148,679		
December	941,219	277	3.53	3	.04	1,591,962	124	.93	3	.02	104,140	1	.12			148,372		
Total, 1918	1,205,442	5,869	4.87	189	.16	936,589	1,489	1.59	36	.04	107,260	74	.69	1	.01	63,090	8	.13

1919																		
January	672,937	401	7.15	14	.25	1,488,683	71	.57	6	.05	68,337					140,396	1	.09
February	471,815	278	7.07	5	.13	1,310,083	83	.76	2	.02	66,104					131,219		
March	406,839	220	6.49	2	.06	1,115,693	44	.47	2	.02	44,634	1	27			123,152		
April	339,836	104	3.67	2	.07	853,425	41	.58	3	.04	29,824					119,801		
May	291,810	58	2.39	1	.04	569,842	17	.36			20,780					108,650		
June	246,903	9	.44			271,633	17	.75			18,562	1	.65			64,166		
July	215,104	8	.45			111,634	10	1.07			20,058					12,508		
August	156,791	4	.31			48,006	6	1.50			18,013					1,741		
September	149,360	2	.17			30,315	2	.79			11,322					1,287		
October	139,877	2	.17			21,055	6	3.42			9,084					185		
November	132,403	8	.73			18,920					8,792					83		
December	135,441	19	1.68			18,379	2	1.31			8,935							
Total, 1919	279,926	1,113	3.97	24	.09	488,139	299	.61	13	.03	27,037	2	.07			58,599	1	.02
Month not stated							4		1									
Total for period	1,965,297	8,778	4.47	265	.13	1,469,656	1,959	1.33	61	.04	145,826	87	.60	2	.01	122,412	9	.07

[a] No deaths occurred among colored enlisted men in Europe.

OCCURRENCE IN THE ARMY IN THE UNITED STATES

Table 60 shows that there were 9,038 primary admissions for scarlet fever reported in the Army in the United States during the war. The occurrence of the disease among white enlisted men contributed the vast majority of admissions. There were 8,778 primary admissions among these troops, with 265 deaths. The admission ratio was 4.47 and the death ratio, 0.13 per 1,000 per annum.

As stated above in discussing the occurrence of scarlet fever in the total Army, the occurrence was of minor importance among colored troops. There were 97 primary admissions among these troops with 2 deaths, giving an admission and death ratio of 0.34 and 0.01 per 1,000 per annum, respectively. Scarlet fever was responsible for the loss of 382,628 days from duty among officers and enlisted men in the United States admitted as primary admissions. The noneffective ratio per 1,000 strength was 0.47. The relative importance of scarlet fever to the Army is better exemplified when compared with the noneffective ratios for several other diseases; for example, the noneffective ratio per 1,000 strength for influenza was 7.09; mumps, 2.58; epidemic meningitis, 0.18; typhoid fever, 0.07. White enlisted men in the United States lost 372,267 days from duty; while colored enlisted men lost 3,814 days. The average duration of hospitalization for white enlisted men was 42.4, for colored enlisted men 43.8, and for the total Army in the United States 42.3 days.

The distribution of scarlet fever in the United States Army during the World War, is graphically represented by States in Chart XLIII. Ratio per 1,000 strength of total reported cases occurring in each State (including camps) is the basis upon which this chart is prepared. No cases were reported from the States of Delaware and Nevada; the number of troops stationed in these States was very small, the mean strength being 3,338 and 165, respectively. The highest ratios, in general, are found in the northern and north central portions of the United States. States in the southeastern part of the United States, generally speaking, had the lowest occurrences. The highest admission ratios were for the States of Montana, Wyoming, Colorado, Utah, and Kansas. These ratios were 53.51, 30.15, 14.99, and 10.55 per 1,000 per annum, respectively. The lowest ratio was for Vermont and Louisiana. This ratio was 0.17 per 1,000 per annum for each of these States. Of the total 8,865 primary admissions for scarlet fever among enlisted men in the United States during the World War, 4,816 occurred in the camps enumerated in Table 62, and 4,049 occurred among enlisted men stationed outside of these camps, as extra-camp cases.

TABLE 62.—*Scarlet fever. Admissions and deaths, by camps of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919*

Camps	Average strength for period, total	White enlisted men				Colored enlisted men				White and colored enlisted men				
		Primary admissions		Deaths		Primary admissions		Deaths		Primary admissions		Deaths		Case fatality rates per cent
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	
Camp Beauregard, La	20,625	3	0.15							3	0.14			
Camp Bowie, Tex	26,193	10	.40	1	0.04					10	.38	1	0.04	10.00
Camp Cody, N. Mex	22,636	61	2.69	2	.09					61	2.69	2	.09	3.27
Camp Custer, Mich	37,631	181	4.99	2	.06					181	4.81	2	.05	1.10
Camp Devens, Mass	47,921	79	1.73	1	.02					79	1.65	1	.02	1.26
Camp Dix, N. J	49,786	139	3.09	1	.02					139	2.79	1	.02	.71
Camp Dodge, Iowa	39,032	386	11.62	8	.24	4	0.69			390	9.99	8	.20	2.05
Camp Doniphan, Okla	26,747	75	2.80	1	.04					75	2.80	1	.04	1.33
Camp Eustis, Va	6,780	5	.79							5	.74			
Camp Forrest, Ga	8,980	6	.67							6	.67			
Camp Fremont, Calif	15,414	14	.91							14	.91			
Camp Funston, Kans	56,222	603	12.05	12	.24	6	.97			609	10.83	12	.21	1.97
Camp Gordon, Ga	44,871	12	.32	1	.03	3	.44	1	.15	15	.33	2	.04	13.33
Camp Grant, Ill	49,256	227	5.36	10	.24	2	.29			229	4.65	10	.20	4.36
Camp Greene, N. C	29,710	65	2.48	3	.11					65	2.19	3	.10	4.61
Camp Greenleaf, Ga	11,959	27	2.26	4	.33					27	2.26	4	.33	14.81
Camp Hancock, Ga	37,994	372	10.22	27	.74	30	18.81			402	10.58	27	.71	6.71
Camp Humphreys, Va	12,836	11	1.13	1	.10					11	.86	1	.08	9.09
Camp Jackson, S. C	42,011	14	.38	1	.03					14	.33	1	.02	7.14
Camp Johnston, Fla	22,267	31	1.56	4	.20					31	1.39	4	.18	12.90
Camp Kearny, Calif	25,472	182	7.15							182	7.15			
Camp Lee, Va	57,635	64	1.25							64	1.11			
Camp Lewis, Wash	47,792	520	11.00	10	.21					520	10.88	10	.21	1.92
Camp Logan, Tex	27,734	37	1.39	2	.08					37	1.33	2	.07	5.40
Camp MacArthur, Tex	25,271	188	7.73	1	.04					188	7.44	1	.04	.53
Camp McClellan, Ala	28,664	32	1.21							32	1.12			
Camp Meade, Md	50,033	186	4.43	5	.12	19	2.36			205	4.10	5	.10	2.43
Camp Mills, N. Y	24,197	74	3.23							74	3.06			
Camp Pike, Ark	49,587	502	12.28	28	.69	6	.69	1	.11	508	10.24	29	.58	5.70
Camp Sevier, S. C	27,786	40	1.53	1	.04					40	1.44	1	.04	2.50
Camp Shelby, Miss	30,432	10	.35			1	.61			11	.36			
Camp Sheridan, Ala	26,507	30	1.17							30	1.13			
Camp Sherman, Ohio	42,750	361	9.77	10	.27	5	.86			366	8.56	10	.23	2.73
Camp Syracuse, N. Y	3,367													
Camp Taylor, Ky	46,962	128	3.01	5	.12					128	2.73	5	.11	3.90
Camp Travis, Tex	44,264	24	.64							24	.55			
Camp Upton, Long Island, N. Y	44,871	85	2.11	2	.05	2	.43			87	1.94	2	.04	2.29
Camp Wadsworth, S. C	31,809	27	.90							27	.85			
Camp Wheeler, Ga	25,726	5	.21							5	.19			
Others	339													
Total	1,270,069	4,816	4.15	143	.12	78	.71	2	.02	4,894	3.85	145	.11	2.96

The remarks made in the beginning of this chapter on the occurrence of scarlet fever in the Army by race and season apply largely to such occurrences in the United States. It was to be expected that the occurrence of this disease, as in the case of other exanthematous diseases, would be greatest during the first months of service, when unseasoned troops were massed in cantonments. This was especially true, when considering the fact that many recruits came from rural districts where the percentage of persons immune to scarlet fever is generally accepted as being low. Although a high percentage of persons of the soldier age are immune to scarlet fever, yet among a large number of soldiers

SCARLET FEVER: BY STATES OF OCCURRENCE, WHITE AND COLORED ENLISTED MEN, UNITED STATES ARMY, FOR THE WORLD WAR PERIOD, APRIL 1, 1917 – DECEMBER 31, 1919.

RATIO PER 1000 STRENGTH

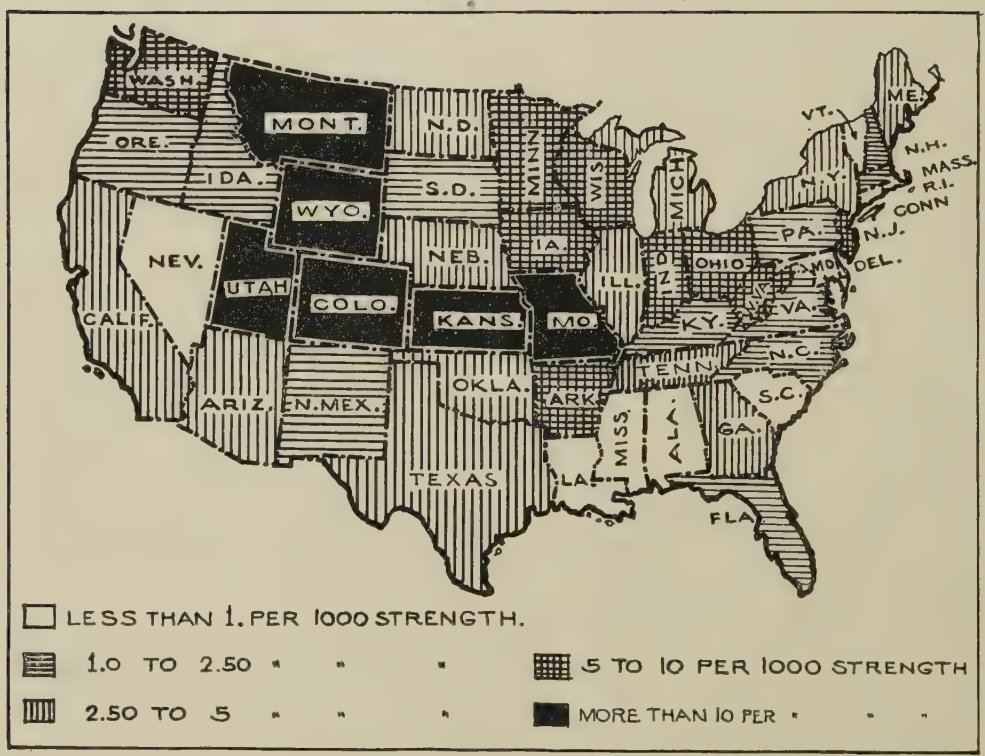

CHART XLIII

nonimmunes will be found. The greater occurrence of scarlet fever in the Army in the United States than in Europe is shown in Table 60. The primary admission rate for the total Army in the United States was 4.04 and for the Army in Europe, excluding Russia, was 1.42 per 1,000 strength. This difference is explained on the basis of length of service, which offered opportunity for the majority of cases of scarlet fever to occur in the United States before the soldier was sent abroad.

On the basis of length of service and season, the largest number of cases and the highest admission ratios were during the late fall, winter, and early spring of 1917 and 1918. (See Table 61.) The highest admission ratio for any period during the war, and for any country in which the American troops served, was 12.37 in January, 1918, for white troops serving in the United States. There were two waves in the Army stationed in the United States during the World War. This is shown best by the occurrence among white enlisted men. The first wave commenced in the fall of 1917, reaching the peak in January, 1918, from which time there was a progressive decrease until the following September. The largest number of primary admissions per month was 1,130 for January, 1918, and the smallest number during that year was in September, which was 46. The admission ratio among white troops was 12.37 in January, 1918, and progressively decreased to 0.42 per 1,000 strength in September. The second wave of occurrence among white troops commenced in October, 1918, and, as in the case of the previous year, ended in January of the following year, 1919, with 401 primary admissions during that month. The admission ratio was 7.15 per 1,000 strength during January. The downward trend commenced in February, 1919, with 278 primary admissions, and reached the low point with two primary admissions in September. The admission ratio decreased from 7.15 in January to 0.17 in September.

OCCURRENCE IN THE AMERICAN EXPEDITIONARY FORCES

The occurrence of scarlet fever in the American Army in Europe was not a matter of grave concern. The total number of primary admissions in Europe (excluding Russia) was 2,370, or about one-fifth of the total number of cases reported for the World War. The admission ratio was 1.42 per 1,000 strength. The total number of deaths from this disease was 74, giving a death rate of 0.04 per 1,000 per annum. There were 106,877 days lost from duty by the total Army in Europe, giving a noneffective ratio of 0.18 per 1,000 strength.

As in the United States the white enlisted men contributed the majority of the cases. There were 1,959 primary admissions, with 61 deaths, among these troops, with admission and death ratios of 1.33 and 0.04, respectively, per 1,000 strength. The noneffective ratio was 0.17 per 1,000 per annum, based on 92,352 days lost from duty. Scarlet fever was rare among colored troops in Europe; there were nine primary admissions and no deaths. The average time lost among them from duty was 53.7 days and the case mortality was nil.

The seasonal occurrence among white troops in Europe followed the same general seasonal trend as in the United States. Two waves of occurrence marked the winters of 1917–18 and 1918–19. The crest of the first wave was reached in January, 1918, with the report of 168 cases and an admission ratio of 10.43 per 1,000 strength. The crest of the second wave was reached in December, 1918, with 124 primary admissions, giving an admission ratio of 0.93 per 1,000 per annum. The crest of this second wave occurred one month earlier than the crest of the second wave in the United States.

Not only was the occurrence less marked among white troops in Europe than in the United States, but there were fewer deaths. The total number of

primary admissions for white troops in Europe was 1,959 and for the United States 8,778. There were 61 deaths among white troops reported in Europe as compared with 265 in the United States.

The duration of hospitalization was longer for colored troops in Europe than for white troops. The average number of days lost from duty by the former in Europe was 53.7 and in the United States 43.8. It is of interest to note also that duration of hospitalization was longer for white men in Europe than in the United States. The duration of hospitalization was, respectively, 47.1 and 42.4 days.

FACTORS INFLUENCING OCCURRENCE

Scarlet fever is an acute infectious disease and unquestionably has a specific cause. The virus, whatever it may be, is one of low infectivity as compared, for example, with that of measles. It is believed that the virus lies in the discharges from the nose and throat; also in the discharges from patients with complications, such as suppurative otitis media occurring during the course of the scarlet fever. There seems to be ample evidence to justify the statement that desquamations during the course of scarlet fever do not contain the virus and, therefore, are not a source of contagion. However, in view of the absence of any positive knowledge of the duration of the period in which patients remain a source of infection, desquamation still remains worthy of being a guide to quarantine. It is not known at just what time the discharges are most heavily laden with the virus, or how long the patient remains an active carrier.

The importance of certain factors influencing the occurrence of scarlet fever has been demonstrated. This disease is a typical disease of childhood, with the majority of cases occurring before the tenth year[1] and 90 per cent before the sixteenth year. From this time the occurrence by age diminishes. Race unquestionably has its influence, and our medical records of the war show conclusively that scarlet fever occurred far more frequently among white troops than among colored troops. The occurrence of this disease among native Filipino, Hawaiian, and Port Rican soldiers was almost negligible. It is true that the diagnosis of any disease which is largely dependent upon the interpretation of skin manifestations is much more difficult in the negro than in the white man. Although this might account for some missed cases, it would not account for the great difference in occurrence in whites and negroes. As in the case with the other exanthematous diseases, scarlet fever had distinct seasonal distributions, with the largest number of cases during the cold, damp months of the year, and the smallest number of cases during the hottest and driest months.

Although scarlet fever was distributed over the United States and reported from nearly all States and camps, in certain camps and certain States the incidence was much greater than in others. Camp Pike, Ark., was a notable center for this disease. The number of cases at Camp Hancock, Ga., was greater than the average in the camps of the United States. The greater occurrence in these camps has been attributed to the poor physical condition of the troops drawn from Mississippi, Louisiana, Arkansas, Alabama, and Georgia. Vaughan and

Palmer [2] held that troops from the Southern States possessed a susceptibility that was general as well as specific; they were subject not only to the ravages of pneumonia, but to other diseases as well, and their death rate from all causes was higher and their sickness incidence was greater than that of troops from other parts of the country.

Statistics contained in the reports of the United States Census Bureau show the occurrence of scarlet fever to be greater in the northern than in the southern portions of the United States. The States of Montana and Colorado showed the highest incidence of scarlet fever during the World War for extra-camp troops; that is, soldiers who were not a part of camp garrisons. The States showing the greatest occurrence among all troops, camp and extra-camp were Montana and Wyoming. Taken alone, the following three camps stood at the head of the list during the war: Camp Lewis, Wash., 10.88; Camp Funston, Kans., 10.83; and Camp Hancock, Ga., 10.58 per 1,000 strength. These ratios include both white and colored troops, and are quoted here to show that, although scarlet fever is more common in the northern part of the United States, as a rule, its occurrence was greatest in some of the camps located in the South during the war, although the troops in such camps were drawn largely from Southern States.

Scarlet fever has been called a "neighborly disease, as it spreads from family to family in direct proportion to the intercourse of people and the interchange of things between families."[1] These conditions exist among troops, and in all probability contributed to the spread of the disease in the Army.

PATHOLOGY

There are no known specific lesions of scarlet fever. Even the skin eruptions disappear after death except in the hemorrhagic form. The pathological anatomy is that following fever and secondary infection by pus organisms. The complications are usually incident to streptococcus invasion. Ludy, Hunt, and Cogswell[3] reported a series of necropsies on scarlet fever cases at Camp Hancock, Ga., and called special attention to the general adenopathy, with involvement of the submaxillary and inguinal lymph glands, as being present "in 100 per cent of the cases." This enlargement was such that one could grasp the glands between the thumb and forefinger and in the fresh subject they gave a mushy feeling. The microscopic pathology was that of hyperplasia, inflammatory in type. Hyperplasia of the mesenteric and retroperitoneal glands and spleen was also present.

SYMPTOMS

During the stage of invasion, scarlet fever is manifested by the following cardinal symptoms and signs: Sudden onset, vomiting, sore throat, elevated temperature, rapid pulse, dryness of the skin, and acute fever. Diagnosis of scarlet fever can not be made with certainty during this stage; however, the above symptom complex served during the war as an index for transferring patients to hospital and placing them in observation wards until an accurate diagnosis could be made. Not until the appearance of the skin eruption is it possible to diagnose scarlet fever, according to most observers. This eruption appears in from one to two days after onset of the disease as a scattered red

punctate rash or a deep subcuticular flush. It appears first on the neck and chest, spreading rapidly to the armpits and over the body in general. It is inflammatory in nature, producing an intense hyperemia; the bleaching of the skin, due to anemia produced by pressure, is quickly relieved upon the release of pressure. The skin, at first, is intensely red, the so-called "boiled lobster" appearance. The rash, scarlet at first, becomes darker in a few days.

The face shows an erythema, with a paleness surrounding the mouth. This perioral pallor is commonly present in scarlet fever. Scaling commences at different times in different cases. It may be slight, with fine desquamation, as was noted in many mild cases during the war; or it may be very extensive, with scales as large as the palm of the hand, in this respect resembling dermatitis exfoliativa. The duration of desquamation also varies and may extend into weeks.

Ludy, Hunt, and Cogswell [3] reported the presence of the "strawberry tongue" in 92.8 per cent of their cases. The intensity of the sore throat is at times great; and when an organized exudate is present on the tonsils, the examination suggests the diagnosis of diphtheria. Before the days of microscopic examinations of throat swabs for the Klebs-Loeffler bacillus, the differential diagnosis of these two diseases was often confused. One hundred and eighty-eight of the primary admissions for scarlet fever during the World War were associated with diphtheria, the diagnosis of which was based on microscopic examinations. These figures are quoted to show the occurrence of diphtheria and scarlet fever as concurrent diseases in the Army during the war.

In the beginning of the disease, the skin of scarlet fever patients feels hot and dry. It later becomes moist and, if pinched, minute hemorrhages from the rupture of capillaries usually occur. This finding is common in scarlet fever, but occurs in some other diseases. The increased fragility of the blood vessels is believed to be the underlying cause of the minute hemorrhages that occur in some of the more severe types of scarlet fever, designated as the hemorrhagic form.

Some writers have laid great stress on the enanthem, claiming that a punctate eruption on the mucous membrane of the palate, tonsils, and cheeks, when combined with a punctate eruption over the armpits and in the groin, is characteristic of scarlet fever. In the 500 cases of scarlet fever studied at Camp Hancock,[3] the eruption occurred on the neck, chest, and abdomen in 40 per cent; the entire body, 26.5 per cent; chest and neck, 17.6 per cent; chest and back, 5.9 per cent; and chest and arms in 5.9 per cent of their cases.

Early albuminuria has long been looked upon as a frequent concomitant of scarlet fever. In the 500 cases reported from Camp Hancock albumin was found in 67.3 per cent and casts in 35.3 per cent cases during the first week.[3] The urine usually shows urobilinogen and is negative for the diazo reaction. The importance of these findings is in the differential diagnosis. Routine examination of the urine was commonly carried out in the base hospitals during the war for the detection of nephritis. The presence of red blood cells was considered of great importance in the diagnosis.

Much has been written on the blood picture in the early diagnosis of scarlet fever, the diagnostic points being leucocytosis and eosinophilia. Friedlander and McCord [4] conducted investigations along these lines at Camp Sherman, Ohio, and reported that 78.9 per cent of the cases showed leucocytosis, while

42.1 per cent showed eosinophilia. Where the white cell count was more than 10,000 they reported leucocytosis and where the number of eosinophiles was more than 2 per cent they recorded eosinophilia. Of 75 cases, 18.6 per cent showed an eosinophilia of 3 per cent or over. Ludy, Hunt, and Cogswell [2] reported eosinophilia of over 5 per cent in 36 per cent of their cases, 4 per cent in 10 per cent, and more than 2 per cent in 54 per cent. These authors believe that the presence of an eosinophilia in a scarlet fever suspect is a valuable point in diagnosis, provided other causes of eosinophilia can be excluded. Leucocytosis of over 12,000 occurred in 19 per cent of the Camp Hancock cases, 12 per cent showed between 10,000 and 12,000 leucocytes, and 40 per cent between 7,000 and 10,000 leucocytes. The prevailing cell, when leucocytosis occurred, was the polymorphonuclear neutrophile. The type of the disease, the intensity of the eruption, and the degree of desquamation bore a definite relationship to the blood picture. The more marked the prodromal symptoms, the greater was the leucocytosis, the less the eosinophilia, and the less the desquamation.

Desquamation commences where the eruption first appears, as a rule, and lasts several weeks. In some instances the desquamation is prolonged into the seventh or eighth week. As previously stated, it is not believed that the scales contain the scarlatina virus, but desquamation was used during the war as an index for releasing patients from quarantine. Desquamation is usually slowest on the palms of the hands and soles of the feet and reference to these areas was usually made before reporting desquamation complete. Ludy, Hunt, and Cogswell [3] believed that scarlet fever, without eruption, exists and that the diagnosis in such cases can be made on the presence of soft inguinal adenitis plus sore throat and some of the other symptoms described as common to scarlet fever.

COMPLICATIONS AND SEQUELÆ

There were 1,781 cases of scarlet fever reported as concurrent with other diseases. The total number of cases reported for the war, primary and concurrent, was 13,456. Among the total primary admissions, 3,825 developed complications or were associated with other diseases while in hospital; that is, 32.7 per cent.

TABLE 63.—*Scarlet fever. Complications, sequelæ, and concurrent diseases, April 1, 1917, to December 31, 1919*

Secondary diseases	Admissions	Deaths	Case fatality rates, per cent	Per cent of primary admissions
Measles	114	7	6.14	0.97
Diphtheria	188	4	2.12	1.61
Erysipelas	38	1	2.63	.33
Diphtheria carrier	71	0		.61
Meningitis carrier	6	0		.05
German measles	32	0		.27
Mumps	259	10	3.86	.22
Septicemia, general	14	8	57.1	.12
Acute articular rheumatism	72	1	1.38	.62
Arthritis	81	7	8.6	.69
Otitis media	363	20	5.5	3.11
Mastoiditis	74	6	8.1	.63
Pericarditis	16	5	31.2	.14
Acute endocarditis	32	4	12.8	.27
Valvular heart diseases	54	1	1.85	.46
Myocarditis and myocardial insufficiency	31	4	13.5	.27
Diseases of the lymphatic system	77	1	1.3	.66
Pneumonia:				
Broncho	257	123	47.8	2.20
Lobar	195	77	39.4	1.67
Nephritis:				
Acute	84	14	16.6	.72
Chronic	48	6	12.5	.41

The more important complications and diseases reported as concurrent with scarlet fever in the Army during the World War are given in Table 63, from which it is seen that otitis media was the most common complication. Otitis media and its complications are, perhaps, the most important complications developing in the course of scarlet fever. This is particularly true on account of the impairment of hearing, with partial or total deafness that often develops. The above table shows that otitis media developed in 3.11 per cent of the total primary admissions. There were 363 such cases, of which 20 died, giving a case mortality of 5.5 per cent. The heart complications were also common. A total of 1.14 per cent of the primary admissions developed heart complications, of which 14 died. Nephritis was not a common complication among the soldiers suffering from scarlet fever, 84 cases of acute nephritis and 48 cases of chronic nephritis having been reported among the total primary admissions. The case mortality, however, was high; that is, 16.6 per cent in the acute cases and 12.5 per cent in the chronic cases. Arthritis complicating scarlet fever was not common during the war; 81 cases or 0.69 per cent of the total admissions, with 7 deaths, were reported. The case mortality was 8.6 per cent. General septicemia was reported in 14 cases and, as would be expected, the case mortality, 57.1 per cent, was high. Diphtheria was frequently associated with scarlet fever. Among the 188 cases, there were 4 deaths, giving a case mortality of 2.12 per cent. The total occurrence of diphtheria among the primary admissions amounted to 1.61 per cent. Measles occurred in 114 cases, with 7 deaths, and German measles in 32 cases, with no deaths. The pneumonias were relatively common among the primary admissions for scarlet fever. The records show 257 cases of bronchopneumonia and 195 cases of lobar pneumonia as complications. The case mortality, as would be expected, was high. It was 47.8 per cent for bronchopneumonia and 39.4 per cent for lobar pneumonia. Occurrence of the pneumonias among the primary admissions totaled 3.87 per cent.

Scarlet fever occurred as a concurrent disease in 344 cases of measles, 64 cases of diphtheria, 54 cases of German measles, 288 cases of mumps, 64 cases of pneumonia, 21 cases of arthritis, and 10 cases of nephritis (Table 64). The case mortality was 2.6 per cent among cases of scarlet fever reported as an associated disease of measles, while it was 6.1 per cent of cases of scarlet fever where measles occurred as a concurrent disease. This same difference occurred where diphtheria and scarlet fever were concurrent. Where diphtheria occurred as a concurrent disease, the case mortality was 2.12 per cent; where the reverse condition existed—that is, where the primary admission was for diphtheria, and scarlet fever was the concurrent disease—the case mortality was 1.5 per cent. Among the 98,225 cases of measles reported as primary admissions, scarlet fever was reported in 0.35 per cent. Among the 10,909 cases of diphtheria, scarlet fever occurred as a concurrent disease in 0.58 per cent.

TABLE 64.—*Admissions and deaths for scarlet fever, concurrent with other diseases, enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919*

Primary diseases	Admissions	Deaths	Case mortality	Primary diseases	Admissions	Deaths	Case mortality
Measles	344	9	2.6	Endocarditis	4	2	50.0
Diphtheria	64	1	1.5	Bronchopneumonia	30	2	6.6
German measles	54	0	0	Lobar pneumonia	34	6	17.6
Mumps	288	2	.7	Nephritis (all)	10	0	----------
Arthritis	21	0	----------				

According to Ludy, Hunt, and Cogswell,[3] reporting their observations in cases of scarlet fever at Camp Hancock, Ga., albuminuria was present in 67.3 per cent during the first week, 58.8 per cent during the second week, and 8.8 per cent at the end of the sixth week of the disease. Casts were present in 35.3 per cent during the first week, 14.4 per cent during the second week, and 2.9 per cent at the end of the sixth week. In another series suppurative otitis media developed in 11 per cent of 500 cases, arthritis in 5.9 per cent, and bronchopneumonia in 6.5 per cent. Three of the cases had relapse and three developed jaundice. Streptococcus throat cultures were positive in 36.2 per cent; 92.8 per cent had "strawberry tongue"; 35 per cent were admitted with skin eruption; 100 per cent had inguinal adenitis, and 65 per cent had the rash of scarlet fever before admission to hospital. An enanthem was present on the hard and soft palates in 92.9 per cent of the cases, and 70 per cent developed marked desquamations. Nephritis was reported as not being common at Camp Hancock. The only serious complications reported were otitis media and pneumonia. The pneumonia was said to have been of a peculiar type, markedly resembling influenza-pneumonia. One case of severe arthritis was reported from this camp.

The occurrence of scarlet fever at Camp Lewis, Wash., was reported as being of a mild type, with few important complications. Pneumonia occurred in three cases and nephritis and endocarditis each in one case. Transient albuminuria was reported in 14 per cent of the cases. Nephritis appears not to have been as common a complication of scarlet fever in the Army as in civil life, where its occurrence is said to be from 10 per cent to 25 per cent.[5]

DIAGNOSIS

The clinical diagnosis of scarlet fever is justified by the presence of such manifestations as fever, with sudden onset; sore throat; fine punctiform rash, involving the hair follicles situated on a normal base, appearing first on the neck and chest, then becoming generalized, vividly red in the beginning, turning darker as the disease progresses; pallor about the mouth; tongue coated and showing prominent red papillæ protruding through this coat; vomiting; early albuminuria; rapid pulse; and eosinophilia. The justification of this diagnosis is increased by the feverish appearance of the patient, the presence of urobilinogen in the urine, absence of the diazo reaction, and presence of peripheral blood capillary fragility.

During the World War, the typical case of scarlet fever was not difficult to diagnose; however, medical officers reported mild cases that did not present the full clinical picture. There were cases also where the differentiation from measles and German measles was difficult. The latter disease at times presented a fine, vivid erythematous rash that strongly resembled that of scarlet fever. It was necessary at times to observe patients in quarantine before a positive diagnosis could be made. Toxic erythema caused confusion in some cases, but observation afforded opportunity to make the differential diagnosis.

The enanthem and submaxillary and inguinal adenopathy were important diagnostic findings in the cases studied at Camp Hancock; the presence of enanthem was reported in 92.9 per cent and the adenopathy in 100 per cent of

the cases.[2] Skin eruption was not present in all cases, and marked desquamation occurred in 70 per cent. Although scarlet fever without eruption was reported during the war,[3] the difficulty of diagnosis was greatly increased without the presence of this valuable diagnostic sign.

PROGNOSIS

If the occurrence of deaths from scarlet fever be taken as an index to the severity of the disease, the ratios for the various camps show a great difference in severity during the war. The death ratios for the large camps in the United States varied from 0 to 0.71 per 1,000 strength. No deaths occurred from scarlet fever at 14 of the large camps. (Table 62.) Camp Hancock, Ga., reported the highest death rate; i. e., 0.71 per 1,000 strength. The death rate at Camp Pike, Ark., was 0.58 per 1,000 per annum. The death ratio for the remaining camps was, in each instance, below this figure. The death ratio for the 4,816 cases occurring in the large camps of the United States was 0.11 per 1,000 strength, and the case mortality varied between broad limits. The highest case mortality rates were reported from Camp Greenleaf, Ga.; Camp Gordon, Ga.; and Camp Johnston, Fla. These were, respectively, 14.8 per cent, 13.3 per cent, and 12.9 per cent. It is noted that the highest case mortality rates were in the southeastern part of the United States. The average case mortality for the camps located in the United States was 2.96 per cent. As shown previously, scarlet fever occurred more frequently among white troops and the death rate was higher than among colored troops.

Scarlet fever was not, to any great extent, the cause of permanent disability in the Army during the war. Table 60 shows that 18 men were discharged from the service on account of disability following this disease. All of these cases were among white enlisted men. The records do not permit such detailed analysis as to make it possible to state the disability more specifically. Since scarlet fever is an acute disease, naturally the 18 cases discharged from the service were discharged on account of some chronic complication, the exact nature of which can not be stated.

PREVENTIVE MEASURES

Since there were no specific preventive measures known for scarlet fever at the time of the World War, the discussion of prophylaxis in this disease is confined to general preventive or control measures. The general measures of value in preventing the spread of scarlet fever depend largely upon the susceptibility of individuals to this disease. The control of this disease is easier than the control of some other acute infectious diseases, for example, measles. Fomites have been shown to harbor the virus; therefore, thorough disinfection or destruction of articles of clothing, etc., was taken cognizance of in the control of the disease during the war. Occurrence of milk-borne epidemics are contained in the literature on this disease; however, milk-borne scarlet fever was not reported in the Army.

The exact time at which patients become a source of danger and the duration of this period have never been determined; since there is no known causative organism, there are no bacteriological guides upon which to base quarantine.

The importance of missed cases and patients developing a relapse after being dismissed from quarantine was referred to by several medical officers during the war. Ludy, Hunt, and Cogswell[3] reported that 35 per cent of the 500 cases at Camp Hancock, Ga., were admitted to hospital with the skin eruption present. These cases must, therefore, have been a source of infection for some time before being transferred to hospital. Some cases of scarlet fever were so mild that the disease had developed fully before transfer was made. It seems probable, then, that cases occurred in many camps where the diagnosis was made late in the disease or not at all, allowing the patient to remain with his organization.

As a general preventive measure, it was customary to quarantine newly arrived troops 14 days before allowing them to mix freely with other members of the camp. This was possible where the number of men was small; however, in most instances this quarantine was never absolute. The quarantine referred to was not solely for the purpose of preventing scarlet fever, but was intended for other diseases as well, especially measles. Such quarantined soldiers were examined once or twice daily for the appearance of contagious diseases.

The common practice, upon identification of a case of scarlet fever, was to send the patient to hospital and place all contacts, or the entire company, in quarantine. This quarantine was regulated by the division surgeon or the senior medical officer present, and was maintained for seven days. The seven-day quarantine seems to have been satisfactory, although there are cases on record where the incubation period seemed to have been longer.

The length of quarantine of the patient was six weeks by regulations. The records show that the average time spent in hospital for all cases was 42.6 days. In the United States this average was 42.3 days, in Europe 45.09 days. During the war, as noted, medical officers did not believe that the scales contained the virus of scarlet fever, but continued to use desquamation as throwing some light on the probable duration of infectivity. It was generally accepted that as long as the patient showed abnormal nasopharyngeal discharges, suppurating otitis media, discharge from an open lesion, or swollen lymph glands about the neck, he should not be discharged from quarantine. These symptoms usually cleared up promptly. The complication, as a rule, that had the longest duration was chronic suppurative otitis media. At Camp Grant, Ill., the presence or absence of eosinophilia was taken as an index to releasing patients from quarantine.

Although precautionary measures were used to prevent patients from leaving the hospital too soon, relapses occurred. The records do not permit of an analysis of these cases. Ludy, Hunt, and Cogswell[3] reported that 5.7 per cent of the cases at Camp Hancock gave a history of previously having had scarlet fever.

TREATMENT

No satisfactory specific treatment was known for scarlet fever before the World War, and none was developed during that time. The course of the disease can not be cut short, but certain precautionary measures have proved of value, especially in reducing the incidence of complications. All cases were

sent to hospital as soon as the disease was suspected, and isolated in wards especially set aside for that purpose. These were wards designated as isolation wards, with from one to a maximum of about six beds each. Where two or more beds were in a room, they were separated by sheet cubicles. In the event of an increased occurrence of this disease in camp, or in the case of contacts, transfer was often made to the hospital upon the presence of fever alone, although of unknown type. Rest in bed during the early stages of the disease, liquid diet, a well-ventilated and well-heated ward, comprised the palliative treatment. The diet was increased in proportion to the general improvement of the patient and falling of the temperature. The records show that attempts were made to prevent otitis media by the use of alkaline antiseptic mouth washes and gargles, and in some instances by the application of silver preparations to the throat. The measures for preventing the occurrence of nephritis included the prevention of body chilling by rest in bed until convalescence was well established, the free use of fluids, and the limitation of proteins in diet, especially in the form of meats. During the stage of desquamation, vaseline or olive oil was used on the skin; and in some base hospitals carbolized vaseline was used where itching was troublesome.

The treatment of complications was symptomatic. As regards otitis media, which was present in more than 3 per cent of the cases, the treatment was, in general, early incision of the drum membrane for drainage, followed by installation of 50 per cent alcohol several times a day into the external auditory canal. Paracentesis of the drum membrane was generally done in the ward.

The nursing and diet services were generally separate for scarlet fever patients, and much attention was paid to the importance of boiling the eating utensils after use, separate thermometers, and destruction of nose and throat secretions. Discharges from suppurating ears and open wounds that developed during the course of scarlet fever were treated in like manner.

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(3) Ludy, John B.; Hunt, Ernest L.; and Cogswell, Lloyd H.: Observations on 500 Cases of Scarlet Fever. *The Military Surgeon*, Washington, 1919, xlv, No. 4, 414.

(4) Friedlander, Alfred, and McCord, C. P.: Notes on the Blood Picture in the early Stages of Scarlet Fever. On file, Historical Division, S. G. O.

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CHAPTER XII

MEASLES [a]

STATISTICAL CONSIDERATIONS

PRIOR TO THE WORLD WAR

During peace times when troops are in garrison, measles is a disease which gives relatively little concern to the medical department of an army; most troops, under such circumstances, having had some years of service, either have had the disease and thus developed an immunity to it, or, having been exposed, have escaped the disease by reason of the fact that they already possessed an immunity. Therefore, during peace times, measles usually has been limited, in so far as serious outbreaks in the Army are concerned, to recruit depots. On the other hand, when the Army has been greatly expanded, as in mobilization for war, the incidence of measles greatly increased. Thus measles has played a very important part during the various wars in which the United States Army has participated.

Chart XLIV has been prepared to show the incidence of measles in the Army for the period 1840–1919.[1] Prior to the Civil War, the Army had no colored enlisted men, so figures for white enlisted men only have been used to make the ratios comparable. This chart shows measles increased tremendously with mobilization of the Union Forces for the Civil War. During the years covered by the Civil War statistics, 67,763 cases were reported, with 4,246 deaths among white troops, with a case fatality of 6.27 per cent. Only a small part of this mortality was directly referable to measles;[2] in many of the regiments only one death was caused by its epidemic occurrence. Since most of the mortality was the result of secondary pulmonary affections, the rate given does not adequately express the situation, for many deaths were charged to the pneumonic lesion without reference to the primary cause.

Following the Civil War the occurrence of measles decreased, and in the year of 1866 the admission ratio was only 1.98 per thousand strength.[3] From this time until mobilization commenced for the Spanish-American War (1898), the disease was not one of great importance in the Army. Although certain of the intervening years were marked by distinct increases, yet the annual admission ratio did not exceed 9 per thousand except during the year of 1896, when it became 10.30.[4] In 1898, the admission ratio rapidly rose to 51.70 per 1,000 per annum.[4] From 1899 until the mobilization of troops on the Mexican border in 1916, the occurrence averaged about 8.5 per thousand per annum.[5]

During the years intervening between the close of the Philippine insurrection (1902) and 1916, serious outbreaks of measles were limited almost entirely to our recruit depots. Thus, during 1911, a severe epidemic, with a 5 per cent mortality, occurred at Columbus Barracks, Ohio.[6] Of the 1,101 cases, with 25 deaths, in the total Army in the United States in 1911, 392 cases with 18 deaths occurred at Columbus Barracks.[6]

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

On a small scale, conditions as they existed at Columbus Barracks during the time mentioned are illustrative of what occurred in some of the camps during mobilization for the World War; that is, recruits from all sections of the country were crowded into barracks, and among them were men from rural districts where there was a large percentage of measles nonimmunes. With overcrowding, particularly during the colder months of the year, epidemics inevitably occurred.

In greater detail, the comparative trends of cases and deaths for the Civil War, the Spanish-American War and Philippine insurrection, and the World War are graphically shown in Chart XLV, by months of occurrence for white and colored enlisted men. From this illustration it is seen that the peak of admissions occurred in the early period of the respective wars. For the World

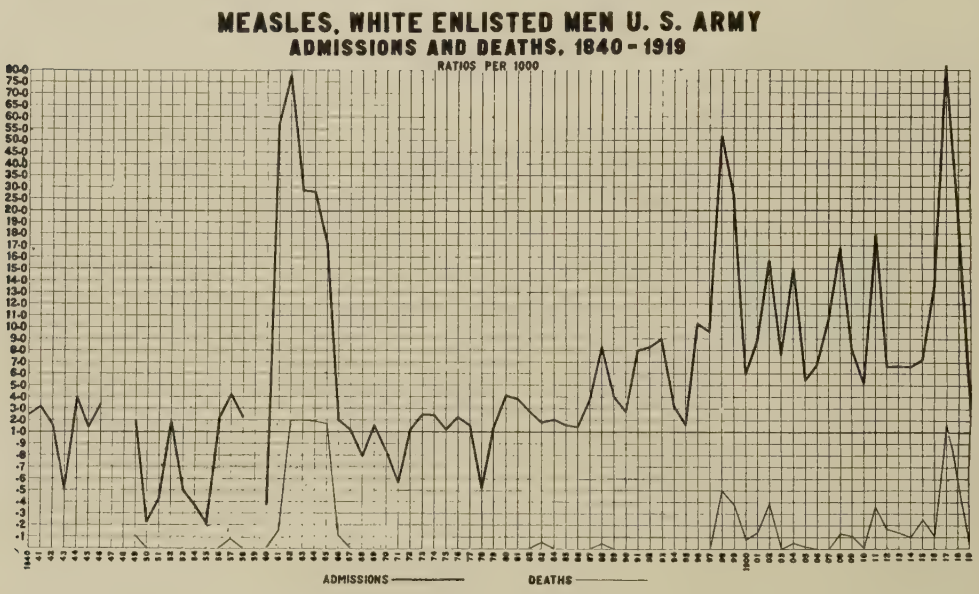

CHART XLIV

War, the peak occurred in November, 1917, and subsequent to that time there was a well-marked decline in the admission ratio. During the Civil War, the peak for admissions was reached during the first year, namely, in December, 1861. The peak was also reached early in the Spanish-American War. Since this war was waged during the summer season, measles and its complications did not become an important epidemiological problem. For the World War, the peak, taken by the death rate trend, also was reached in November, 1917. This was not the case in the Civil War, as the peak did not occur until March, 1864. During the second and third winters of the Civil War the death rate rose out of proportion to the number of cases reported. This may be accounted for by improvement in diagnosis during the latter period of the war and in cases being actually charged to measles rather than to its pulmonary complications. The increased death rate may be accounted for by the enlistment of colored troops after July, 1863, as they had higher death rates due to pulmonary complications

The number of deaths was not great following measles during the Spanish-American War and Philippine insurrection. The peak, as shown on Chart XLV, was reached in March, 1902.

The admission rate for white and colored troops combined for the entire period of the Civil War, from May, 1861, to June, 1866, was 32.22 per thousand per annum; the death rate was 2.02. During the Spanish-American War and Philippine insurrection, from May, 1898, through June, 1902, the admission and death ratios per thousand strength were 26.06 and 0.32, respectively. For the World War, based on occurrence in the United States and Europe only and from April, 1917, to and including December, 1919, the admission ratio was 25.28 and death ratio 0.63 per thousand per annum. It may be inferred, then, that measles was better controlled during the period of the World War as a whole than during the other two wars under consideration, and while the death rate was twice as high as that for the Spanish-American War and Philippine insurrection, it was less than one-third as high as the corresponding rate during the Civil War.

DURING THE WORLD WAR

Discussions which follow are based, generally, upon the primary admissions. For the total Army the admission, death, and noneffective ratios were 23.79, 0.57, and 1.25 per thousand per annum, respectively. American officers and enlisted men contributed 96,817 admissions, 2,367 deaths, and a loss of time from duty amounting to 1,864,477 days. This occurrence was among the total mean annual strength of approximately 4,000,000 men. Officers, as shown in Table 65, with an aggregate strength of 206,382, contributed 974 admissions and 3 deaths, the loss of time from duty amounted to 12,015 days. The noneffective ratio was 0.16 per thousand per annum. The admission and death ratios were, respectively, 4.72 and 0.01 per thousand, the lowest in the Army where large bodies of troops were concerned. This is probably accounted for by the difference in age and living conditions among officers as compared with enlisted men. Among American enlisted men there were 95,843 primary admissions, with 2,364 deaths. The admission and death rates were 24.66 and 0.61 per thousand strength, respectively, and the loss of some 1,800,000 days, with a noneffective ratio of 1.31 is credited to them. Enlisted native troops, serving in their home territory, had 1,408 primary admissions among a total of a mean annual strength amounting to 36,022. There were three deaths with admission and death ratios of 39.08 and 0.08 per thousand per annum, respectively. From the above it is seen that the highest admission ratios were among native troops, and the lowest among American officers.

It was the opinion of medical officers that deaths did not follow uncomplicated measles, but were due to complications and concurrent diseases. It was the practice in the statistical division of the Surgeon General's Office, as noted elsewhere (p. 5), to charge all subsequent developments to the primary cause of admission to sick report. This accounts for the deaths, permanent disability, and much of the time lost from duty credited to measles in this chapter. Therefore, for a comprehensive understanding of this chapter the reader should take the method of computation into consideration.

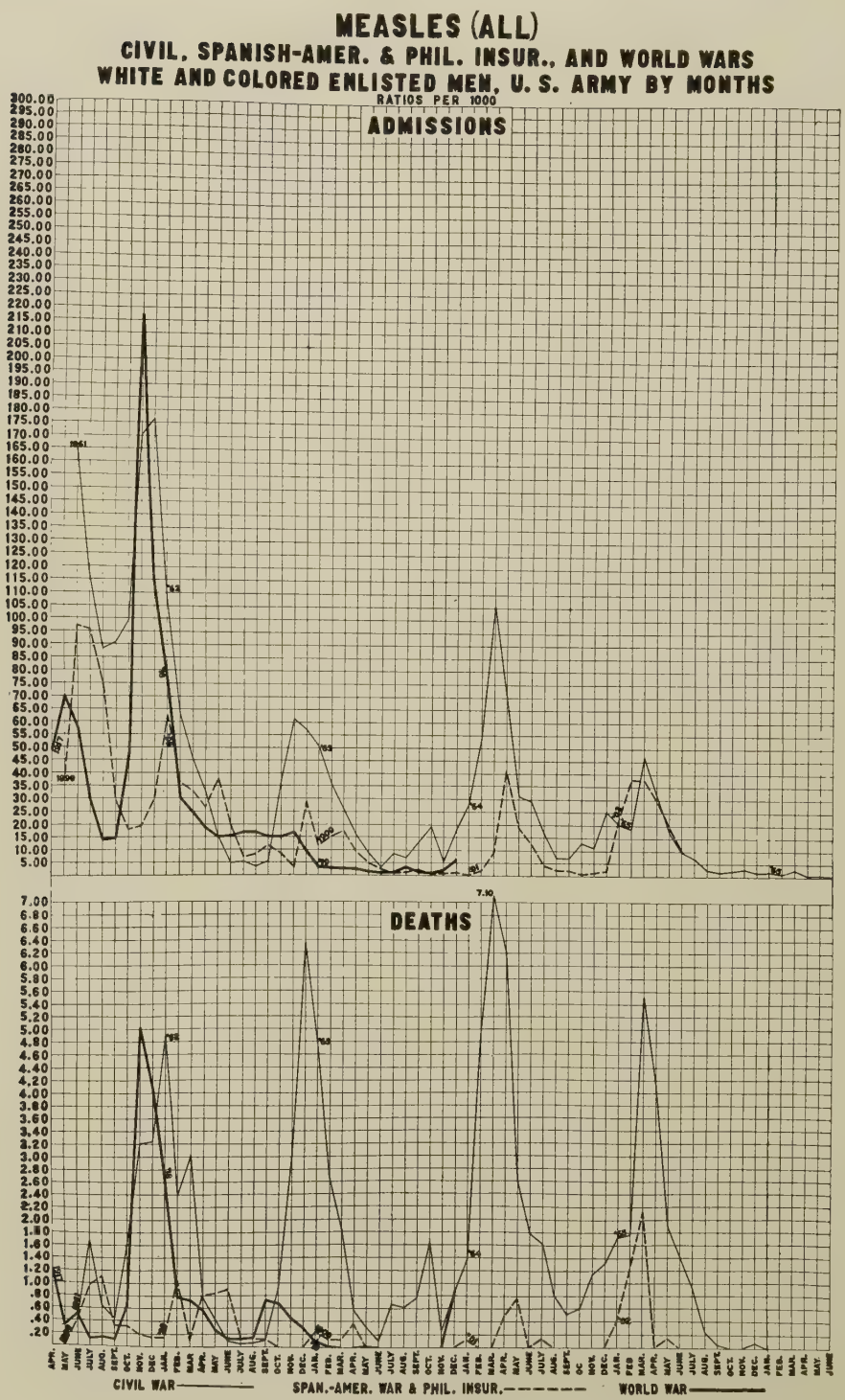
MEASLES (ALL)
CIVIL, SPANISH-AMER. & PHIL. INSUR., AND WORLD WARS
WHITE AND COLORED ENLISTED MEN, U. S. ARMY BY MONTHS
RATIOS PER 1000
ADMISSIONS
DEATHS
7.10
CIVIL WAR
SPAN.-AMER. WAR & PHIL. INSUR.
WORLD WAR

CHART XLV

TABLE 65.—*Measles. Admissions, deaths, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and rates per 1,000*

	Total mean annual strengths	Admissions		Deaths		Discharges for disability		Days lost	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Non-effective ratio per 1,000 strength
Total officers and enlisted men including native troops	4,128,479	98,225	23.79	2,370	0.57	149	0.04	1,877,944	1.25
Total officers and enlisted men American troops	4,092,457	96,817	23.65	2,367	.58	149	.04	1,864,477	1.25
Total officers	206,382	974	4.72	3	.01			12,015	.16
Total American troops:									
White	3,599,527	90,112	25.01	2,228	.62	142	.04	1,723,795	1.31
Colored	286,548	4,870	17.00	116	.40	7	.02	106,551	1.02
Color not stated		861		20				22,116	
Total	3,886,075	95,843	24.66	2,364	.61	149	.04	1,852,462	1.31
Total native troops (enlisted)	36,022	1,408	39.08	3	.08			13,467	1.02
Total Army in the United States including Alaska:									
Officers	124,266	813	6.54	1	.01			9,511	.21
White enlisted	1,965,297	80,546	40.98	1,889	.96	138	.07	1,503,341	2.10
Colored enlisted	145,826	4,039	27.71	97	.67	7	.05	87,946	1.65
Total enlisted	2,111,123	84,585	40.06	1,986	.94	145	.07	1,591,287	2.07
Total officers and men	2,235,389	85,398	38.20	1,987	.89	145	.06	1,600,798	1.96
U. S. Army in Europe, excluding Russia:									
Officers	73,728	124	1.68	1	.01			2,084	.08
White enlisted	1,469,656	7,529	5.12	318	.22	2	.00	189,822	.35
Colored enlisted	122,412	668	5.46	19	.16			16,017	.36
Color not stated		847		20				21,822	
Total enlisted	1,592,068	9,044	5.68	357	.22	2	.00	227,661	.39
Total officers and men	1,665,796	9,168	5.50	358	.21	2	.00	229,745	.38
Officers, other countries	8,388	37	4.41	1	.12			420	.14
U. S. Army in Philippine Islands:									
White enlisted	16,995	107	6.30					1,960	.32
Colored enlisted	4,456	2	.45					38	.02
Total enlisted	21,451	109	5.08					1,998	.26
U. S. Army in Hawaii:									
White enlisted	16,161	169	10.46	3	.19			2,657	.45
Colored enlisted	3,319	40	12.05					582	.48
Total enlisted	19,480	209	10.73	3	.15			3,239	.46
U. S. Army in Panama: (White enlisted)	19,688	121	6.15					1,640	.23
U. S. Army in other countries not stated:									
White enlisted	(a)	263		2		1		6,984	
Colored enlisted	(a)	8						411	
Color not stated		10						263	
Total	14,232	281	19.75	2	.14	1	.07	7,658	1.47
Transports:									
White enlisted	97,498	1,377	14.12	16	.16	1	.01	17,391	.49
Colored enlisted	10,535	113	10.73					1,557	.41
Color not stated		4						31	
Total	108,033	1,494	13.83	16	.15	1	.01	18,979	.48
Native troops enlisted:									
Philippine Scouts	18,576	127	6.84	1	.05			1,412	.21
Hawaiians	5,615	186	33.13					1,373	.67
Porto Ricans	11,831	1,095	92.54	2	.17			10,682	2.47

[a] Separate strength of white and colored not available.

OCCURRENCE IN THE UNITED STATES

More than eight-tenths of the primary admissions were among troops serving in the United States. (See Table 65.) There were 85,398 such admissions among the troops serving at home and in Alaska. In so far as Alaska is concerned, for all practical purposes the number of measles admissions there was so small it need not be considered. The total annual mean strength of the Army in the United States was about two and a quarter million men, and among these there were 1,987 deaths. The admission and death ratios were 38.20 and 0.89 per thousand per annum, respectively. The loss of time from duty was considerable and amounted to 1,600,798 days, with a noneffective ratio of 1.96 per thousand. Enlisted men serving in home territory contributed 145 of the 149 cases discharged for disability. There were 84,585 primary admissions for measles among enlisted men, 80,546 of which were among white enlisted men. The annual admission ratio for the total enlisted was 40.06 per thousand strength, the highest experienced by these troops due to measles in any country in which they served. Of the total 2,370 deaths charged to primary admissions, 1,986 occurred among the enlisted men serving at home. The death ratio was 0.94 per thousand. One and a half million days were lost from duty, with the highest noneffective ratio that occurred among American troops serving in any country during the World War. It was 2.07 per thousand strength.

RELATION OF OCCURRENCE TO MOBILIZATION

Apparently no disease was more closely allied to mobilization than was measles. This is shown quite clearly in Chart XLVI. During the fall and early winter of 1917, when mobilization camps were being organized, barracks and tents were overcrowded and inadequately heated, and it was impossible to supply the men with sufficient warm clothing.[7] These adverse conditions were augmented by an unusually early and severe winter. The draft brought large numbers of persons together from all walks of life and from every environment. The inducted men were principally young adults and included not only the generally immune city boy, but also vast numbers of rural lads who had never before been exposed to the infection.

The influence of introducing large numbers of nonimmunes into the camps during the war is shown by Chart XLVI, which depicts the comparative trend between mobilization and measles. In November, 1918, the drafting of men ceased and recruiting was not resumed until March of the following year. This, of course, tended promptly to bring the measles rate down to a low level. Additional factors which had a tendency to reduce the occurrence of measles in the Army below the 1917 peak were the better housing, clothing, isolation, and heating facilities which became available in 1918. The occurrence, however, ran generally parallel with mobilization. Length of service also, influenced occurrence; in more than two-thirds of the cases the men had had three months' service or less. In other words, the disease developed during the early camp service of the recruit.

OCCURRENCE BY CAMPS

Analysis by camps of occurrence in the United States shows great difference in extent to which this disease prevailed. It varied from 1.19 per thousand strength at Camp Syracuse, N. Y., and 7.27 at Camp Dix, N. J., to 164.67 per thousand at Camp Pike, Ark., among white enlisted men. (Table 66.) The location of the camp played no determining rôle; it was largely a matter of

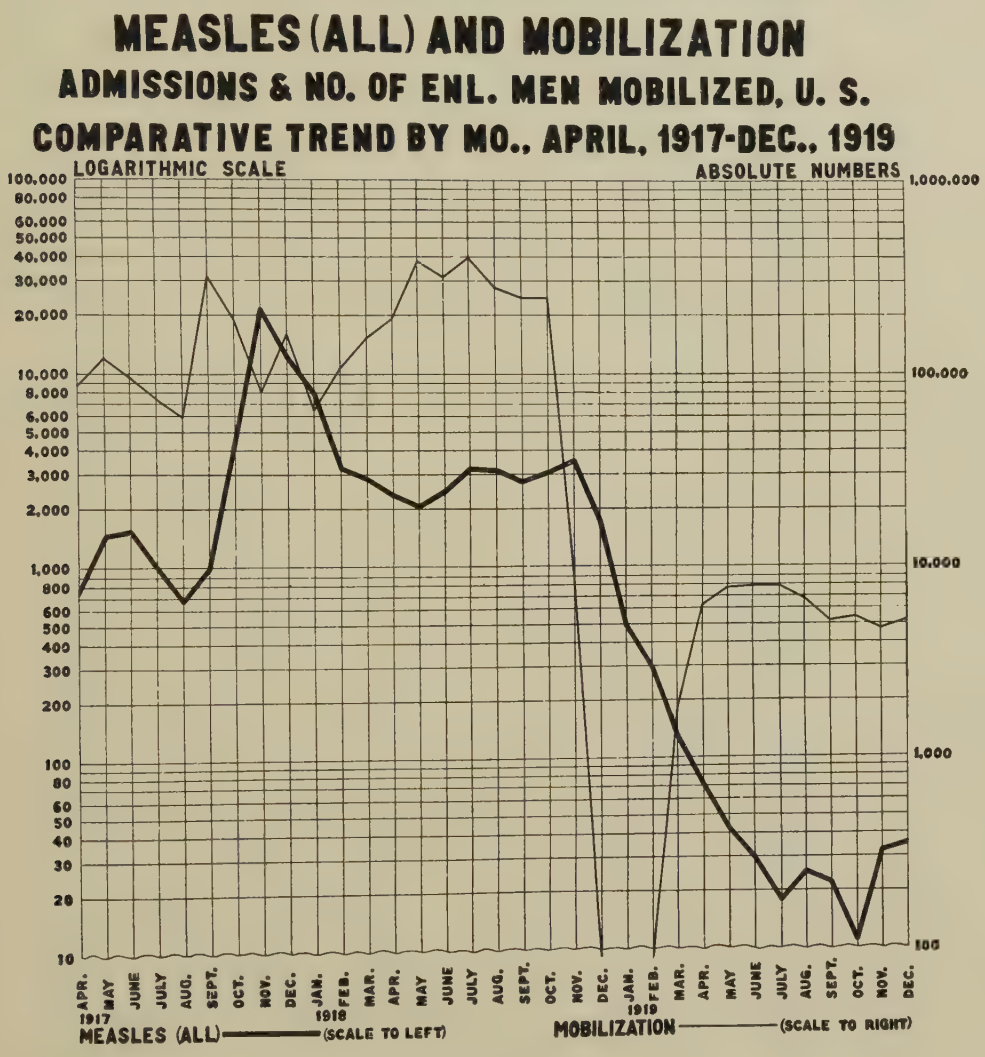

CHART XLVI

one camp drawing a higher percentage of immunes or nonimmunes than another. The maximum occurrence was attributed to troops from the southeastern portion of the country (Chart XLVII). From a study of the population of the eastern portion of the United States, one is justified in saying that the northeastern section is thickly settled while the southeastern is sparsely settled. In other words, the bulk of the population in the former have lived in cities and

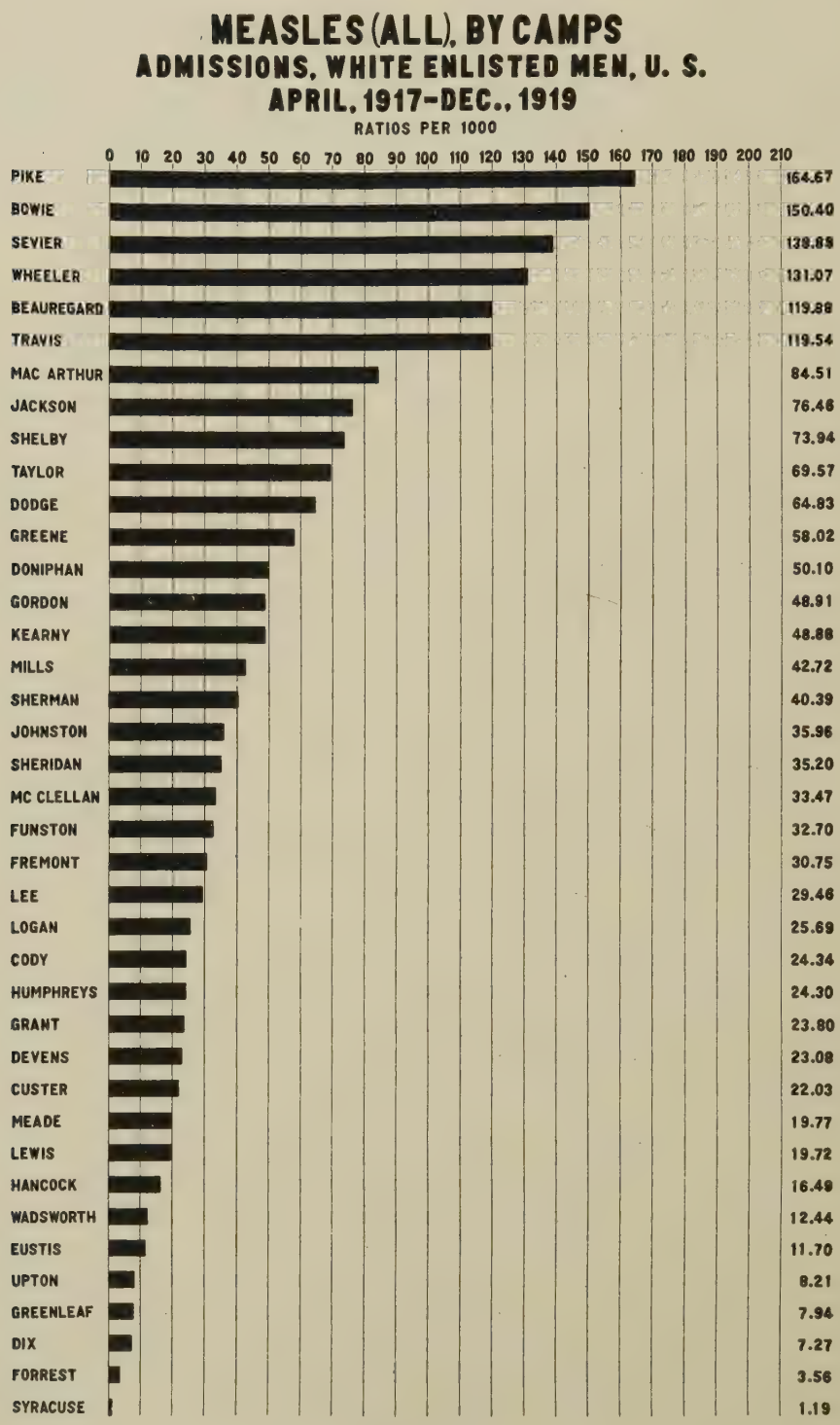
MEASLES (ALL), BY CAMPS
ADMISSIONS, WHITE ENLISTED MEN, U. S.
APRIL, 1917–DEC., 1919
RATIOS PER 1000
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210
PIKE 164.67
BOWIE 150.40
SEVIER 138.88
WHEELER 131.07
BEAUREGARD 119.88
TRAVIS 119.54
MAC ARTHUR 84.51
JACKSON 76.46
SHELBY 73.94
TAYLOR 69.57
DODGE 64.83
GREENE 58.02
DONIPHAN 50.10
GORDON 48.91
KEARNY 48.88
MILLS 42.72
SHERMAN 40.39
JOHNSTON 35.96
SHERIDAN 35.20
MC CLELLAN 33.47
FUNSTON 32.70
FREMONT 30.75
LEE 29.46
LOGAN 25.69
CODY 24.34
HUMPHREYS 24.30
GRANT 23.80
DEVENS 23.08
CUSTER 22.03
MEADE 19.77
LEWIS 19.72
HANCOCK 16.49
WADSWORTH 12.44
EUSTIS 11.70
UPTON 8.21
GREENLEAF 7.94
DIX 7.27
FORREST 3.56
SYRACUSE 1.19

Chart XLVII

in close proximity, and as such may be classified as urban. In the latter, or southeastern portion, there are some large cities, but the bulk of the population may be called rural. A large proportion of the inhabitants in urban States have contracted measles in childhood, while in rural States a large percentage have not been exposed to the disease. Applying this information in discussing occurrence by camps, it is noted, for example, that Camp Pike, Ark., which stands at the head of the list, drew its quota of troops from Southeastern States, namely, Alabama, Arkansas, Louisana, Mississippi, and Tennessee. Camp Bowie, Tex., which stands second, drew its quota from Arkansas, Louisiana, and Texas. Camp Sevier, S. C., standing third, drew from Alabama, Kentucky, North Carolina, and South Carolina. Camp Wheeler, Ga., fourth on the list, drew its quota from Alabama, Florida, Georgia, Louisana, and Mississippi. On the other hand, Camp Grant, Ill., which drew its quota principally from Illinois, and Camp Dix, N. J., which drew principally from New York and New Jersey, stand at or near the bottom of the list of camps. The last three States are thickly settled and may be classified as urban States; while the other States mentioned, generally speaking, may be classified as rural.

Next to Camp Pike, which had a high rate of occurrence for most of the epidemic diseases, comes Camp Travis, Tex. Camp Pike had 6,730 such admissions for measles among white, and 314 among colored, enlisted men. Camp Travis had 4,484 among whites and 337 among colored. Camp Pike also heads the list in the number of deaths, with a total of 211 men for the period of the war, 197 of which were among white troops. Camp Bowie, on the other hand, had the highest death rate for the period, as shown in Table 66.

From the figures given above it is seen that measles was of far greater importance among white than among colored enlisted men. The comparative occurrence in the two races is illustrated in Chart XLIX, which shows admissions, deaths, case fatality, noneffectiveness, days lost, and discharges for disability among white and colored enlisted men serving in the United States. The admission and death ratios, as well as noneffective ratio and discharges for disability, were greater among white than colored enlisted men. The case fatality and average days lost per case were greater for colored than for white enlisted men.

From the standpoint of epidemiology, the six months period commencing October 1, 1917, marks the measles period for the Army. During this time there were 51,022 primary admissions among white enlisted men, and 1,487 among colored, making a total of 52,509, or more than one-half of the total admissions for the entire Army serving in all countries.

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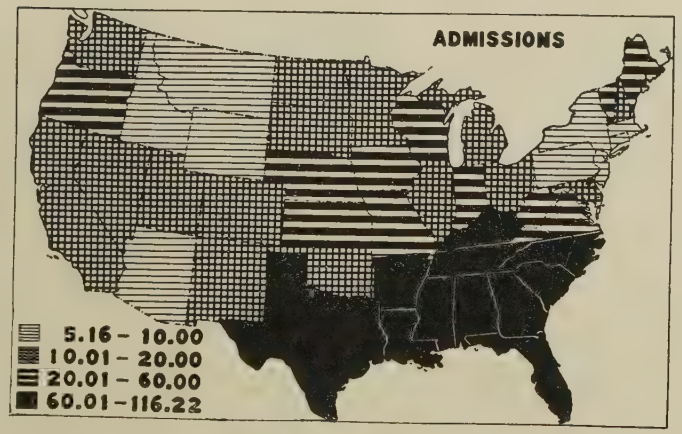
MEASLES (ALL), BY NATIVE STATES
WHITE ENL. MEN, U.S. & EUROPE, U.S. ARMY
APRIL, 1917–DEC., 1919

RATIOS PER 1000



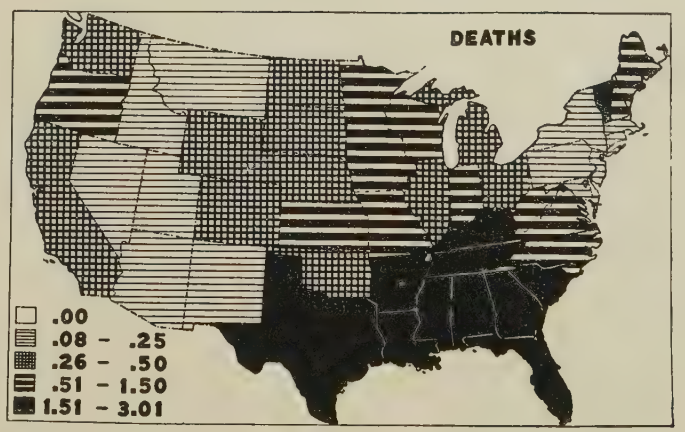


CHART XLVIII

TABLE 66.—*Measles. Admissions and deaths, by camps of occurrence, white and colored enlisted men in the United States, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

Camps	Total mean strength	White enlisted men				Colored enlisted men				White and colored enlisted men				Case fatality rates per cent
		Admissions		Deaths		Admissions		Deaths		Admissions		Deaths		
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	
Camp Beauregard, La	20,625	2,422	119.88	66	3.27	18	42.66			2,440	118.3	66	3.2	2.70
Camp Bowie, Tex	26,193	3,796	150.40	142	5.63	29	30.43			3,825	146.03	142	5.42	3.71
Camp Cody, N. Mex	22,636	551	24.34	27	1.19					551	24.34	27	1.19	4.9
Camp Custer, Mich	37,631	799	22.03	19	.52	16	11.80			815	21.66	19	.50	2.33
Camp Devens, Mass	47,921	1,055	23.08	20	.44	85	38.29	2	0.90	1,140	23.79	22	.46	1.93
Camp Dix, N. J	49,786	327	7.27	5	.11	58	12.05	1	.21	385	7.73	6	.12	1.56
Camp Dodge, Iowa	39,032	2,154	64.83	40	1.20	276	47.56	9	1.55	2,430	62.26	49	1.26	2.02
Camp Doniphan, Okla	26,747	1,340	50.10	44	1.65					1,340	50.10	44	1.65	3.28
Camp Eustis, Va	6,780	74	11.70			4	8.77			78	11.50			
Camp Forrest, Ga	8,980	32	3.56							32	3.56			
Camp Fremont, Calif	15,414	474	30.75	6	.39					474	30.75	6	.39	1.27
Camp Funston, Kans	56,222	1,637	32.70	71	1.42	125	20.27	1	.16	1,762	31.34	72	1.28	4.09
Camp Gordon, Ga	44,871	1,861	48.91	89	2.34	459	67.28	25	3.66	2,320	51.70	114	2.54	4.91
Camp Grant, Ill	49,256	1,009	23.84	9	.21	123	17.73	1	.14	1,132	22.98	10	.20	.88
Camp Greene, N. C	29,710	1,519	58.02	67	2.56	52	14.74	2	.57	1,571	52.88	69	2.32	4.39
Camp Greenleaf, Ga	11,959	95	7.94	2	.17					95	7.94	2	.17	2.1
Camp Hancock, Ga	37,994	600	16.48	21	.58	44	27.59	1	.63	644	16.95	22	.58	3.42
Camp Humphreys, Va	12,836	237	24.30	7	.72	141	45.72	5	1.62	378	29.45	12	.93	3.17
Camp Jackson, S. C	42,011	2,820	76.46	66	1.79	202	39.39			3,022	71.93	66	1.57	2.18
Camp Johnston, Fla	22,267	714	35.96	5	.25	118	48.96	1	.41	832	37.36	6	.27	.72
Camp Kearny, Calif	25,472	1,245	48.88	37	1.45					1,245	48.88	37	1.45	2.97
Camp Lee, Va	57,635	1,501	29.43	31	.61	117	17.65	1	.15	1,618	28.07	32	.56	1.97
Camp Lewis, Wash	47,792	932	19.72	10	.21	8	15.24			940	19.67	10	.21	1.06
Camp Logan, Tex	27,734	685	25.69	10	.38	16	14.97	1	.94	701	25.28	11	.40	1.57
Camp MacArthur, Tex	25,271	2,055	84.51	37	1.52	23	24.13			2,078	82.23	37	1.06	1.78
Camp McClellan, Ala	28,664	888	33.47	8	.30	62	29.11			950	33.14	8	.28	.84
Camp Meade, Md	50,033	830	19.77	26	.62	85	10.56	1	.12	915	18.29	27	.54	2.95
Camp Mills, N. Y	24,197	980	42.72	13	.57	23	18.30	1	.80	1,003	41.45	14	.58	1.40
Camp Pike, Ark	49,587	6,730	164.67	197	4.82	314	36.02	12	1.38	7,044	142.05	209	4.22	2.97
Camp Sevier, S. C	27,786	3,636	138.88	109	4.16	49	30.51	1	.62	3,685	132.62	110	3.96	2.99
Camp Shelby, Miss	30,432	2,128	73.94	43	1.49	22	13.32			2,150	70.65	43	1.41	2
Camp Sheridan, Ala	26,507	902	35.20	15	.59	8	9.04			910	34.33	15	.57	1.65
Camp Sherman, Ohio	42,750	1,493	40.39	25	.68	226	39.07	1	.17	1,719	40.21	26	.61	1.51
Camp Syracuse, N. Y	3,367	4	1.19							4	1.19			
Camp Taylor, Ky	46,962	2,962	69.57	77	1.81	98	22.34			3,060	65.16	77	1.64	2.52
Camp Travis, Tex	44,264	4,484	119.54	52	1.39	337	51.28	5	.76	4,821	108.92	57	1.29	1.18
Camp Upton, N. Y	44,871	330	8.21	6	.15	75	16.06	2	.43	405	9.03	8	.18	1.98
Camp Wadsworth, S. C	31,809	375	12.44	9	.30	3	1.79			378	11.88	9	.28	2.38
Camp Wheeler, Ga	25,726	3,134	131.07	62	2.59	38	20.94			3,172	123.30	62	2.41	1.95
Others	339					3	8.85	3	8.85	3	8.85	3	8.85	100.00
Total	1,270,069	58,810	50.72	1,473	1.27	3,257	29.45	76	.69	62,067	48.87	1,549	1.22	2.49

MEASLES (ALL). COMPARATIVE RATES

WHITE & COLORED ENL. MEN-UNITED STATES

APRIL, 1917 — DEC., 1919

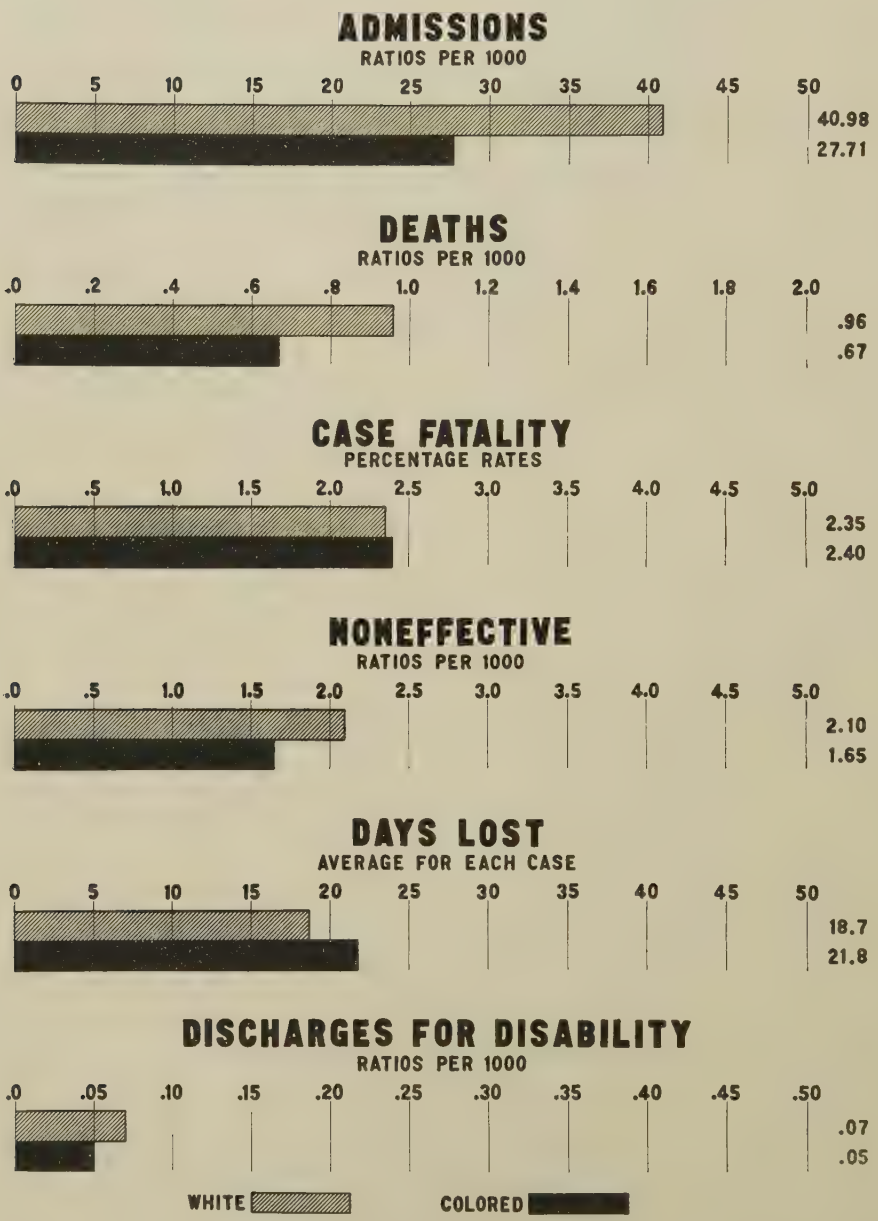


CHART XLIX

The occurrence of measles at Camp Wheeler, Ga., may be taken as typical of camp occurrence.[8] The construction of the camp was not concluded until November, 1917. The first troops arrived on September 5, and by September 20 practically all of the National Guard troops of the division had arrived, totaling some 11,000 men. Of these, probably 3,000 were recruits of about three months' service. (Measles had been occurring in the regiments since the time of their muster in June, 1916, and most of the regiments had experienced considerable epidemics of both measles and pneumonia on the Mexican border during the winter of 1916–17; the Alabama troops had especially suffered at Nogales, Ariz.) The total sick report was about 3 per cent. On October 14, 1917, the first draft men arrived, about 4,000 in number; others continued to come, until by October 28, over 10,000 had arrived. These inducted men brought measles on every train; cases were taken from trains where they had been shut up for from a few hours to 24 hours or more in closed cars filled with men. It can scarcely be wondered that measles got out of control among these men and among the recruits of the various regiments. The number of admissions which had been 7 on October 19, rose to 14 on October 21, 44 on the 23d, 70 on November 2, 102 on the 5th, 118 on the 7th, and reached its maximum with 174 admissions on November 22. By December 7, the conflagration had burned entirely out. There were approximately 3,000 cases among the 10,000 drafted men. It seemed that there were about 30 per cent of nonimmunes.

The following observations were obtained from the respective histories of base hospitals throughout the United States.[9]

At Camp Custer, Mich., admissions for measles increased in numbers from the beginning of mobilization; however, the cases were very mild in character and of a type easily confused with German measles. On January 5, 1918, about 2,000 men arrived in this camp from an overcrowded recruit depot in a near-by State. Many of these soldiers were suffering from severe upper respiratory tract infections which included laryngitis, bronchitis, and pneumonia. More than 300 cases were brought to hospital within a few days. The disease, however, was not confined to the new men, but soon spread to others in camp, and the measles cases, which formerly had been mild in character, now became severe and marked the beginning of an epidemic of empyema. It was in January, 1918, that the measles incidence began to assume epidemic proportions.

At Camp Dodge, Iowa, the incidence of measles was associated invariably with an increase in the strength of the command. The weather is said to have played no causative rôle here, as it did in other camps. The high incidence was dependent upon the arrival of new troops, the percentage of susceptibles, possible delay in diagnosis, and cross infections in the base hospital.

Camp Fremont, Calif., reported two epidemics of measles, one late in 1917 and the other in February and March of 1918, neither of which was serious, and only an occasional case of pneumonia as a complication.

In the month of December, 1917, measles made its first appearance at Camp Gordon, Ga., almost immediately assuming epidemic proportions, taxing the capacity of the hospital to its utmost. Among troops from Georgia, Ala-

bama, and Tennessee came the overwhelming preponderance of the measles cases, while troops transferred from Camps Upton, Dix, and Lee were relatively free. This difference, as stated elsewhere, was apparently due to the fact that the southern troops came from rural communities and had never been exposed to measles, whereas the northern troops were largely city dwellers.

The most serious epidemic that affected troops at Camp Kearny, Calif., was measles. The number of cases reached its height on January 22, 1918, when 115 cases were admitted to hospital.

About the 1st of November, 1917, measles began to enter the hospital at Camp Lee, Va., and epidemics of this disease occurred thereafter, simultaneously with the arrival of new draft men.

At Camp Funston, Kans., a measles epidemic, beginning about October 18, 1917, and reaching its crest during the week of December 20–28, gradually subsided by February 15, 1918, after which time the disease did not exist in epidemic form. During the interval October 18, 1917, to May 18, 1918, about 3,000 cases were admitted to sick report, among 22,854 hospital admissions, or about 13 per cent.

Measles was constantly present at Camp Shelby, Miss., but at no time reached the point where it could be considered an epidemic. It increased with the advent of new troops, particularly those from the rural districts. The first case was admitted about October 1, 1917, and, up to March, 1918, there were 1,505 such admissions.

At Camp Sevier, S. C., measles began to appear almost immediately upon the arrival of the first troops in the fall of 1917. It assumed epidemic proportions with some 3,500 cases. Within 10 days after the epidemic ceased, measles was reintroduced into camp by the arrival of new troops.

Camp Travis, Tex., reported 4,203 cases of measles. The height of the epidemic occurred in the latter part of November and early in December, 1917. The maximum number of admissions was 175 per day. This epidemic died out about the middle of January and was followed by a smaller one in March, 1918, which persisted for about two months.

At Camp Merritt, N. J., both measles and German measles were camp infections during the early months of mobilization; however, not to a serious degree. The fact that the two diseases coexisted made their handling rather difficult as differential diagnosis was not easy. The number of cases was small as compared with the occurrence in many other camps. Up to July 30, 1918, 963 cases of measles and 93 of German measles were admitted to the hospital. In the three weeks preceding the outbreak of influenza in the fall of 1918, an epidemic of measles occurred, chiefly among the soldiers from Camp Gordon.

OCCURRENCE IN THE CIVIL POPULATION

The medical profession accepts measles as a disease of childhood because approximately 90 per cent of the cases in civil life occur before the age of 10 years. The occurrence of measles in all ages, in the civil population is not exactly comparable with the occurrence among the age groups as represented by

soldiers, yet even with the added age groups of the civil population it will be shown that measles had a greater occurrence ratio in the Army than among the home population. Table 67 shows the reported cases of measles and deaths, with ratios per thousand in the registration area of the United States during the period 1917–1919. The population is estimated and taken from public health records for the year 1918, and the total ratios for the respective years are based upon this population. This table shows that 529,498 cases were reported in the registration area among a population of approximately 100,000,000 persons of all ages; the annual ratio was 5.29 per 1,000 for the year 1917. During this year 9,466 deaths were reported, giving an annual death ratio of 0.09 per thousand. During the same year the admission ratio in the Army was 92.24 per annum and the death ratio 2.18. In other words, although all ages are included in the civilian occurrence, including the ages in which measles is most prevalent, the disease was approximately eighteen times more common in the Army than among the civilian population. In this connection, however, it should be remembered that these figures include only reported cases in the registration area, and undoubtedly many cases, as well as deaths, occurred that were never reported.

During 1918 the disease was less prevalent in the United States than it was in 1917, both among civilians and soldiers; in the registration area 429,764 cases and 9,944 deaths were reported, with occurrence and death ratios of 4.29 and 0.099 per thousand per annum, respectively, while in the Army in the United States, during the same period, among enlisted men there were, 38,447 primary admissions, with 908 deaths. The admission and death ratios were, respectively, 29.29 and 0.69 per thousand strength. During the following year (1919) the number of cases and deaths was considerably less. In the civil population there were 178,528 cases reported with 2,316 deaths, while in the Army 1,211 primary admissions, with 18 deaths, were recorded among enlisted men. The occurrence ratio in the civil population was 1.78 and death ratio 0.02 per thousand, while these ratios in the Army were 3.95 and 0.06 per thousand strength. Therefore, it may be said that measles was prevalent in the civil population in the beginning of the war and decreased in its occurrence throughout this period. The same may be said for the occurrence in the Army.

TABLE 67.—*Measles and population, United States registration area, all ages, by States of occurrence, showing estimated population July 1, 1918. Admissions and deaths. Absolute numbers and ratios per 1,000* [a]

State	Estimated population 1918	1917				1918				1919			
		Admissions		Deaths		Admissions		Deaths		Admissions		Deaths	
		Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000
Alabama	2,395,270	19,193	8.119	466	0.197	6,220	2.6	470	0.196	1,106	0.47	54	0.023
Arizona	272,034					162	.6	37	.136			5	.015
Arkansas	1,792,965	7,845	4.442	216	.122	5,335	3.0	336	.187	615	.35	51	.029
California	3,119,412	21,953	7.248	188	.062	23,194	7.4	154	.049	3,969	1.18	14	.004
Colorado	1,014,581	10,374	10.497	69	.070	2,080	2.1			146	.16	3	.003
Connecticut	1,286,268	7,462	5.897	126	.100	5,450	4.2	85	.066	5,884	4.30	99	.072
Delaware	216,941							14	.065			1	.005
District of Columbia	401,681	3,807	10.309	14	.038	7,001	17.4	48	.119	187	.43	1	.002
Florida	938,877					2,187	2.3	137	.146	775	.81	43	.045
Hawaii	223,419	103	.469	3	.014			11	.049	135	.53	1	.004
Illinois	6,317,734	49,512	7.941	766	.123	7,575	1.2	341	.054	18,844	2.93	298	.046
Indiana	2,854,167	30,083	10.609	550	.194	5,583	2.0	120	.042	5,055	1.73	70	.024
Iowa	2,224,771					1,198	.5	214	.096	144	.06	24	.010
Kansas	1,874,195	22,464	12.130	233	.126	10,793	5.8	313	.167	998	.57	12	.007
Kentucky	2,408,547							341	.142			204	.085
Louisiana	1,884,778	10,534	5.673	250	.135	3,525	1.9	254	.135	418	.23	30	.017
Maine	782,191	3,035	3.904	130	.167	1,647	2.1	103	.132	55	.07	4	.005
Maryland	1,384,539	10,613	7.726	117	.085	14,660	10.6	155	.112	3,709	2.57	44	.031
Massachusetts	3,832,790	23,880	6.324	366	.097	29,212	7.6	519	.135	9,984	2.61	183	.048
Michigan	3,133,678	12,453	4.025	241	.078	5,906	1.9	259	.083	7,096	1.96	170	.047
Minnesota	2,345,287	8,303	3.591	121	.052	3,727	1.6	89	.038	4,469	1.89	101	.043
Mississippi	2,001,466	49,422	25.004	546	.276	42,045	21.0	732	.366	3,215	1.80		
Missouri	3,448,498							60	.017			24	.007
Montana	486,376	3,885	8.215	40	.085	1,288	2.6			807	1.50	10	.019
Nebraska	1,296,877					1,584	1.2	13	.010	655	.51	3	.002
Nevada	114,742	1,465	13.229	1	.009								
New Jersey	3,080,371					28,437	9.2	523	.170	4,774	1.53	55	.018
New York	10,646,989	60,860	5.818	892	.085	74,395	7.0	1,293	.121	19,882	1.93	355	.034
North Carolina	2,468,025					8,069	3.3			5,768	2.27		
North Dakota	791,437	1,135	1.483	22	.029	615	.8	7	.009	552	.86	10	.016
Ohio	5,273,814	27,971	5.367	564	.108	14,065	2.7	270	.051	16,788	2.94	197	.035
Oklahoma	2,377,629	11,264	4.919	168	.073			254	.107			37	.018
Oregon	888,243	4,628	5.369	55	.064	4,742	5.3	57	.064	407	.52	3	.004
Pennsylvania	8,798,067	31,417	3.628	513	.059	51,836	5.9	802	.091	45,710	5.27		
Porto Rico	1,247,677	7,001	5.683	1,372	1.114	1,746	1.4	425	.341	133		20	
Rhode Island	637,415	720	1.150	75	.120	3,647	5.7	128	.201	218	.36	16	.027
South Carolina	1,660,934	5,646	3.436	183	.111	2,245	1.4	81	.049	359	.21	8	.005
South Dakota	735,434	1,028	1.434	3	.004	1,320	1.8	33	.045	157	.25		
Texas	4,601,279	4,746	1.051	672	.149	4,356	.9	1,009	.219				
Utah	453,648	15,035	33.873	104	.234	5,274	11.6	34	.075	183	.41	2	.004
Vermont	366,192	10,426	28.569	79	.216	1,086	3.0	15	.041	1,728	4.90	16	.045
Virginia	2,234,030	23,294	10.526			20,546	9.2			4,823	2.10	73	.032
Washington	1,660,578	17,244	10.795	203	.127	5,166	3.1	102	.061	1,894	1.41	20	.015
West Virginia	1,439,165	3,922	2.776	50	.035	1,438	1.0			1,898	1.31		
Wisconsin	2,553,983	5,711	2.260	61	.024	19,376	7.6	100	.039	4,342	1.66	54	.021
Wyoming	190,380	1,064	5.752	7	.038	1,033	5.4	6	.032	646	3.37	1	.005
Total	100,157,374	529,498	5.2865	9,466	.09451	429,764	4.29086	9,944	.09928	178,528	1.78246	2,316	.02312

[a] Source of information: Reprints Nos. 505 (1917), 551 (1918), 643 (1919), Public Health Reports, U. S. Public Health Service, Washington.

OCCURRENCE IN THE AMERICAN EXPEDITIONARY FORCES

Among the total of the mean annual strengths for the American Expeditionary Forces of 1,665,796 officers and men, there were recorded 9,168 primary admissions for measles and 358 deaths. The admission and death ratios per thousand strength, respectively, were 5.50 and 0.21. Among these cases there was a loss of time from duty amounting to 229,745 days, giving a noneffective ratio of 0.38 per thousand per annum.

The vast majority of cases were among white enlisted men. (See Table 65.) These troops contributed 7,529 of the primary admissions, a ratio of 5.12. Colored enlisted men contributed 668 primary admissions with a ratio of 5.46 per thousand strength. Of the total deaths, 318 were among white enlisted men and 19 among colored. There was 1 death among officers and 20 among enlisted men, whose color was not stated. The loss of time from duty among white troops amounted to 189,822 days, and for colored, 16,017. The noneffective annual ratios were, respectively, 0.35 and 0.36. From these figures it is apparent that the occurrence of measles and the noneffectiveness were greater among colored than among white troops. The death ratio, however, was higher for the latter.

Occurrence by months is better shown with figures for white than with figures for colored enlisted men. The first cases among white troops were reported during the month of June, 1917, when 7 primary admissions were recorded. The number steadily increased until January, 1918, when 507 primary admissions were recorded. During the spring there were from 100 to 200 cases per month; however, commencing in the late summer, the number of cases increased until between 800 and 900 primary admissions were recorded per month, with the largest number of cases during September. In 1919, the number of primary admissions was small, due to the withdrawal of the forces from Europe and the discontinuance of forwarding troops from the United States. This applies to the beginning of 1919 and not to the latter part, as recruiting was resumed and replacements sent to the army of occupation in Germany during the latter half of the year, thus accounting for the increase in occurrence among those troops.

Chart L shows the trend taken by admissions and deaths for enlisted men serving in Europe. The peak was reached in July, 1917. This was followed by a decrease until September, when the trend again took an upward course, reaching a second but lower peak in November. Until February, 1918, the admission ratio remained between 25 and 50 per thousand, after which time the occurrence took a downward trend until April. From that time until the date the armistice was signed the trend of occurrence was about horizontal. The occurrence diminished in December and continued through January, 1919. Commencing in the summer, the trend suddenly took an upward course, reaching approximately 9 per thousand, followed by sudden decrease in September, reaching the lowest admission ratio for troops in Europe during the war. During October, 1919, the trend was upward, reaching approximately 35 per thousand; this was due to replacements sent to Germany as mentioned above.

Emerson,[10] in a report on communicable diseases in the American Expeditionary Forces, stated that 8,207 cases of measles and 86 deaths occurred between July 1, 1917, and April 30, 1919, giving a case mortality of 1.05 per cent. He explained that the high incidence rates in the first months, up to and including January, 1918, as compared with the rates after that time, were probably

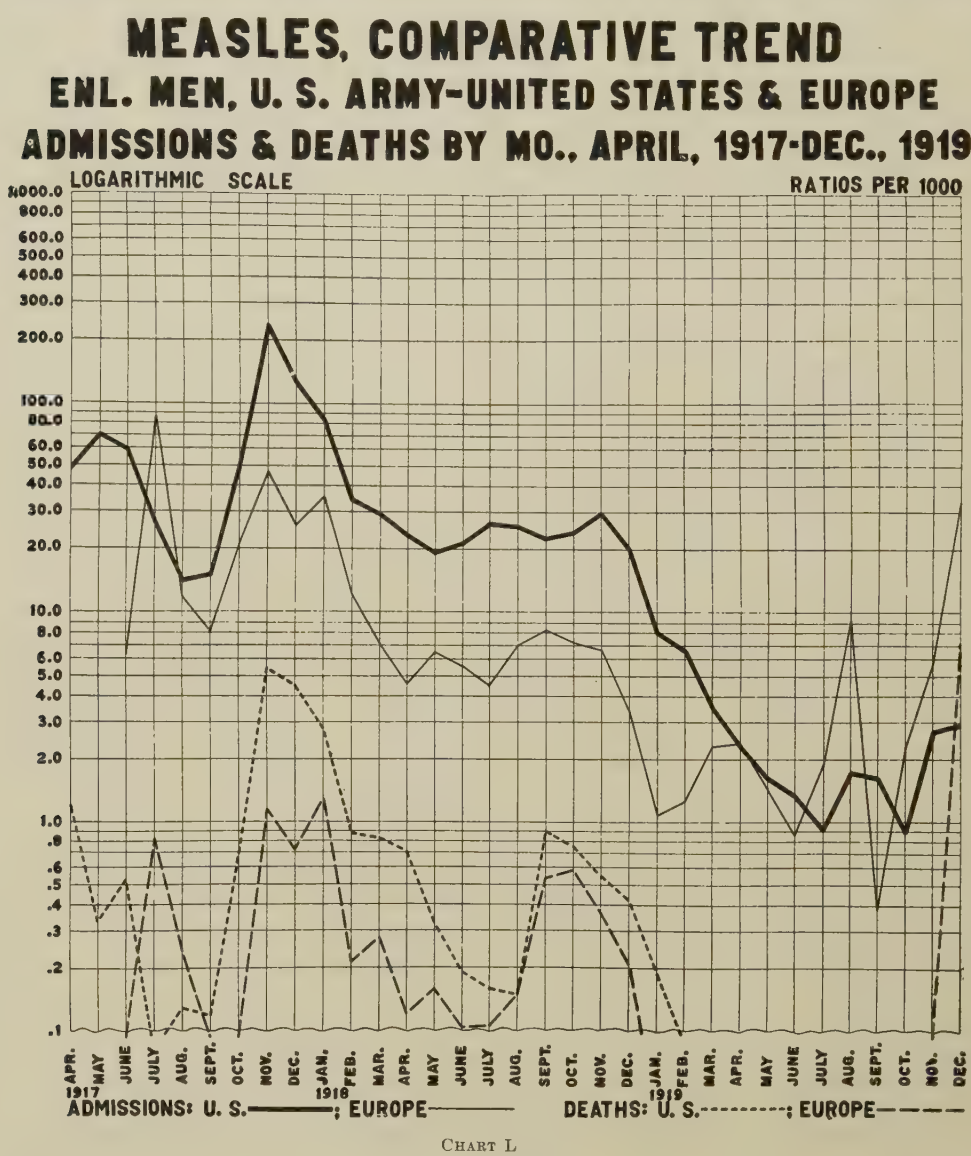


Chart L

due to the fact that among troops who came over before the spring of 1918 there was a very much higher percentage of men who had not passed through measles or been exposed to epidemics in the training camps in the United States than was the case with troops arriving in the American Expeditionary Forces after February, 1918. In the first 18 months of the American Expedi-

tionary Forces, measles was very largely confined to troops just arriving at base ports, or to detachments of recent arrivals at the replacement camps or army units to which they were often hastily forwarded without being held over the incubation period. Between 50 and 80 per cent of all cases in the American Expeditionary Forces were reported from week to week in base ports—that is, up to the signing of the armistice. The number varied greatly according to the arrival of transports or convoys. After the discontinuance of new troop arrivals and the stabilization of commands, measles played but an insignificant part among diseases in the American Expeditionary Forces. The cases that did occur after January 1, 1919, were chiefly in other parts of the American Expeditionary Forces than the base ports, especially in the armies and in the advance sections. Contrary to the general belief, as expressed by medical officers in the United States, Emerson held that measles, as a precedent or contributing cause to pneumonia, played a very unimportant rôle in the American Expeditionary Forces, as it was rare.

There is no reason to believe that measles in the American Expeditionary Forces was to any noticeable extent due to infections acquired by the soldiers from association with the French civil population.[10]

FACTORS INFLUENCING OCCURRENCE

It is generally accepted that one attack renders the individual lastingly immune. Recurrences in unquestionable cases are rare; therefore, with a disease so markedly contagious as measles, it is reasonable to assume that persons who have lived in close contact with others have developed measles in early life. This explains the larger percentage of immune persons among city dwellers and the susceptibility among country persons. These comparative facts are borne out by occurrences among recruits and drafted men obtained from urban and rural districts for the Army.

It is generally conceded that mobilization has a direct bearing on the occurrence of measles. This is due to the huddling together of susceptibles, a condition that can not be prevented in military life. During the World War many of the men were not only housed in standard barracks, but they also had a common mess and a common amusement hall.[11] In all these places they came in close contact while indoors. Some camps had central heating plants, while others had one or more stoves in each room.[11] The former camps were generally located in the northern portion of the United States; the latter were generally in camps located in the South.[11] Where heat was evenly distributed throughout the rooms, as in steam-heated barracks, men did not huddle together so much for the purpose of keeping warm or for amusement; in camps where stoves were used, men would collect around the stoves,[7] and while in this close contact the virus of respiratory diseases was spread through droplet infection. Coughing, sneezing, and spitting were common. Outdoor exercises and duties, such as close-order drill, may have contributed to the spread of the disease, but certainly to a far lesser degree.

The occurrence of measles in the Army shows that it is most prevalent in the cold months. It is true it occurs during all months, but overcrowding is most common in cold weather, and as a result all acute respiratory diseases are

then more common. With a large number of recruits suddenly brought into camp, collected from every environment—immunes, persons actually suffering from the disease, and susceptibles—often arriving in camp on the same train, in the same cars, and placed in the same barracks, outbreaks were inevitable.

Race as a factor is subject to question. Measles was more common among white than among colored troops. On the other hand, the Porto Ricans suffered more than any other troops in the American Army, the occurrence being more than three times that among the whites. The Hawaiian troops serving in their own country suffered second. There appears to be no explanation for the greater susceptibility of these persons over negroes. The difference in the records may be explained by the increased difficulty in diagnosing this disease among colored persons.

The importance of measles to the Army during the World War, en grosse, and the relative importance among the several racial constituents, are shown in Table 68. The comparative occurrence during the World War of measles among white and colored enlisted men from the South and from other sections of the United States is shown in Table 69. The occurrence was approximately four times greater among southern white enlisted men than among white troops from the other sections of the country. About the same is true for southern colored enlisted men. Not only was this true for admission ratios, but also for death ratios. The case fatality was slightly higher among the southern white enlisted men, while southern colored enlisted men had a fatality slightly below that of colored enlisted men from the other sections of the United States.

TABLE 68.—*Measles. Admissions, deaths, discharges for disability, and days lost, by race, enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

Race	Absolute numbers					Annual ratios per 1,000 strength				Per cent	
	Admissions	Deaths	Discharges for disability	Total days lost	Days lost per case	Admissions	Deaths	Discharges for disability	Noneffective	Case fatality rates	Case discharged for disability rates
White	90,112	2,228	142	1,723,795	19.1	25.01	0.62	0.04	1.31	2.47	0.16
Colored	4,870	116	7	106,551	21.9	17.00	.40	.02	1.02	2.38	.14
Filipino	127	1	-------	1,412	11.1	6.84	.05	-------	.21	.79	-------
Hawaiian	186	-------	-------	1,373	7.4	33.13	-------	-------	.67	-------	-------
Porto Rican	1,095	2	-------	10,682	9.8	92.54	.17	-------	2.47	.18	-------
Color not stated	861	20	-------	22,116	25.7	-------	-------	-------	-------	2.32	-------
Total Army (enlisted men)	97,251	2,367	149	1,865,929	19.2	24.80	.60	.04	1.30	2.43	.15

TABLE 69.—*Measles. Admissions, deaths, and case fatality rates, white and colored enlisted men, United States Army, by sections of the United States, April 1, 1917, to December 31, 1919*

	Absolute numbers		Annual ratios per 1,000 strength		Case fatality rates (per cent)
	Admissions	Deaths	Admissions	Deaths	
Southern white enlisted men	41,581	1,136	66.87	1.83	2.73
White enlisted men from other sections of the United States	46,494	1,071	16.53	.38	2.30
Southern colored enlisted men	4,220	103	21.48	.52	2.44
Colored enlisted men from other sections of the United States	487	13	6.79	.18	2.67
Total white enlisted men	88,075	2,207	25.64	.64	2.51
Total colored enlisted men	4,707	116	17.55	.43	2.46

Officers suffered less than enlisted men. (See Table 65.) There are two possible explanations for this: First, officers lived in individual billets or with one or several other officers; overcrowding was the exception; their relationship to enlisted men did not bring them in close contact with them. Second, officers represented an older age group, and as such had greater opportunities for having contracted the disease at some prior date. The individual billeting of officers deserves chief attention in explaining why officers suffered less than enlisted men from measles.

An analysis was made of 28,837 primary admissions for measles, white enlisted men, to determine the influence of length of service on the occurrence of measles. Among this number, 11,528 men had less than two months' service when they were admitted to sick report. Including men with three months' service, in 20,991 instances, measles occurred before these men had been in the service 100 days. This, as will be explained below, was a matter of much importance. Continuing the analysis further, it will be seen that the number of cases progressively decreased with each additional month of service for the first year, which contributed 28,002 of the 28,837 cases analyzed.

SYMPTOMS

Repeated observations made by medical officers lead one to believe that measles has perhaps one of the most constant periods of incubation for any of the eruptive diseases; that is, reckoned from the date of exposure to the appearance of the eruption. It was 13 days, and, in fact, was so regular that the 14-day quarantine period was considered entirely satisfactory. Reckoned from the date of exposure to the period of invasion, the time varied from 9 to 11 days. This seemed to represent the consensus of opinion of medical officers.

The period of invasion is the most important stage from an epidemiological point of view. It is characterized by headache, chilliness, fever, mild catarrhal manifestations of the eyes, nose, throat, and bronchi, and cough. During this stage the individual does not feel sufficiently sick to report sick or be confined to bed. It is usually impossible to diagnose the disease during the early stages of this period, and, since the nasopharyngeal secretions have been proven to contain the virus during the stage of invasion, and since the soldier associates freely with his comrades during this time, the great danger of spreading the infection is obvious. Accordingly, the Office of the Surgeon General, the chief surgeon, A. E. F., and camp epidemiologists throughout the Army, repeatedly emphasized the importance of recognizing early symptoms of the disease. The initial symptoms, namely, coryza and catarrhal manifestations of the eye, suggest that the infectious agent develops first in the respiratory tract, but the primary lesion is not known.

This period merges into the period of eruption, which manifests itself by an enanthem and an exanthem. The first changes, the enanthem, are seen in the mucous membrane of the mouth and throat as a catarrhal injection. On the buccal surface, Koplik spots appear. Hackett [12] stated that at Camp Upton, N. Y., inspections were made of suspects twice daily, when Koplik spots and eruption were carefully looked for. These spots, however, were never seen. The Koplik spots were looked for as a routine in measles cases and suspects in

the Army during the war, but their presence was only occasionally reported. Generally speaking, cases in the Army were seen late in the period of invasion and usually the diagnosis was not made until the skin eruption had developed, by which time the Koplik spots are lost in the eruption on the mucous membrane of the mouth.

The exanthem appears as red, flat, slightly elevated papules developing in from three to five days after the beginning of catarrhal symptoms. It is first noticed on the temples, neck, forehead, and about the edge of the hair. The eruption has a dusky hue as distinguished from the bright red of scarlatina. From these locations it spreads over the body. It was during the early eruptive period that the vast majority of cases were admitted to our military hospitals during the World War.

The period of desquamation is characterized by a fine furfuraceous peeling of the epidermis, involving also the palms of the hands and soles of the feet. It lasts one or two weeks and is present in all cases; however, where the skin is oiled it may not be noticeable. In years gone by, it was a practice to hold patients in quarantine in military hospitals until this desquamation was complete. The scales are now looked upon as harmless and, therefore, of practically no value except in diagnosis. Although measles without eruption is recognized, there is no discoverable record of such cases in the Army.

The urine often shows albumin, especially during the febrile period, and the diazo reaction is positive in about three-quarters of the cases. The latter may be of diagnostic value, especially when confusion with scarlatina exists. This test was only sparingly used during the war.

The blood picture is not characteristic. During the period of incubation there is a leucocytosis involving the polynuclear cells. In the period of invasion the number of white cells decreases; during the period of eruption there is a leucopenia; during desquamation, the number rises to normal in uncomplicated cases. This blood picture was considered of some value in the contagious service at the base hospital, Camp Grant, Ill., during the fall of 1917 and winter of 1918, especiallyin distinguishing measles from scarlet fever.[13]

Several types of measles are recognized, depending upon severity such as mild, hemorrhagic, malignant, and relapsing. Generally speaking, the disease, as reported, was mild in the Army during the war, but not without exception.

Hamburger and Fox,[14] reporting upon two measles epidemics at Camp Taylor, Ky., said the first epidemic was quite severe and the majority of patients were acutely ill from the start. The soldiers who later developed pneumonia and empyema, were particularly prostrated upon entrance to hospital, with flushed face, dusky cyanosis, full, bounding pulse, dyspnea, and labored, grunting breathing. The cyanosis was most striking, as one could almost tell from the color of the patient on admission to hospital that he was to develop or was already developing acute pneumonia. The type of pneumonia varied; however, in most instances it was grouped as diffuse lobular or bronchopneumonia. This first epidemic occurred during September, October, and November, 1917; the second epidemic, which occurred in March, April, and May, 1918, was complicated not only by measles-pneumonia but also by a

streptococcus epidemic, and was distinctly more severe than the first epidemic. Patients came into the hospital more acutely ill and prostrated than during the first epidemic, and died in considerably higher numbers. They died in spite of treatment, and nothing that could be done made the slightest impression on their condition.

COMPLICATIONS, SEQUELÆ, AND CONCURRENT DISEASES

In barracks where soldiers are housed, as well as in civilian institutions, such as asylums, schools, and other places where large numbers of persons live in dormitories, measles is more commonly followed by complications than where cases occur and are treated in the better class of private homes. This is due to cross infection by carriers, not of the measles virus but of such organisms as the streptococcus, which spreads principally through droplet infection.

Among the 98,225 primary admissions to sick report during the World War with the diagnosis of measles, there were reported 22,809 complications, sequelæ, and concurrent diseases. This does not mean that 22,809 cases of measles developed conditions directly attributable to it. This was the number of such diagnoses made after the individuals were admitted to hospital.

The more important complications and concurrent diseases reported among the primary admissions for measles during the war are given in Table 70. As has long been known, the most important and frequent complications of measles are the pneumonias and otitis media. Experience during the war was no exception to this rule.

TABLE 70.—*Measles. Concurrent diseases and complications, enlisted men in the United States and Europe, April 1, 1917 to December 31, 1919*

Concurrent diseases and complications	Admissions		Deaths		Case fatality rates (per cent)
	Absolute numbers	Ratios per 1,000 [a]	Absolute numbers	Ratios per 1,000 [a]	
Bronchopneumonia	4,463	47.67	1,584	16.92	35.49
Otitis media	3,926	41.93	122	1.30	3.11
Lobar pneumonia	1,820	19.44	602	6.43	33.08
Mumps	1,028	10.98	21	.22	2.04
Suppurative pleurisy	645	6.89	268	2.86	41.55
Mastoiditis	566	6.05	18	.19	3.18
Scarlet fever	344	3.67	9	.10	2.62
Tuberculosis of lungs	343	3.66	31	.33	9.04
Diphtheria and results	149	1.59	9	.10	6.04
Erysipelas	108	1.15	14	.15	12.96
Serofibrinous pleurisy	105	1.12	28	.30	26.67
Cerebrospinal meningitis (epidemic)	93	.99	37	.40	39.78
German measles	38	.41			
Pericarditis	34	.36	18	.19	52.94
Keratitis	31	.33			
Endocarditis, acute	23	.25	8	.09	34.78
Acute miliary tuberculosis	9	.10	9	.10	100.00
Others	9,084	97.02	428	4.57	4.71
Total	22,809	233.22	3,206	32.64	14.06

[a] Ratio per 1,000 of measles.

Table 70 shows 4,463 cases of bronchopneumonia, with 1,584 deaths. The admission and death ratios per 1,000 cases of measles were 47.67 and 16.92, respectively; the case fatality was 35.49 per cent. The next most common

complication was otitis media. There were 3,926 cases of measles reported with this complication, of which 122 resulted fatally. The otitis media developed in 4.2 per cent of the cases. The third most common complication was lobar pneumonia; there were 1,820 such cases, with 602 deaths. The admission and death ratios per 1,000 cases of measles were 19.44 and 6.43, respectively, the case fatality was 33.08 per cent. It is generally conceded that lobar pneumonia is not a common complication of measles; lobular or bronchopneumonia is the type usually seen. A review of some of the clinical records indicates that not all diagnoses of lobar pneumonia following measles were correct, and that in some instances at least the diagnosis should have been bronchopneumonia.

Pleurisy was not an uncommon complication—there were 645 cases of suppurative pleurisy and 105 of the serofibrinous variety recorded among the primary admissions. There were 296 deaths reported among these cases. The case fatality with suppurative pleurisy was 41.55 per cent. The cases were preceded by pneumonia. Mastoiditis was recorded in 566 cases following otitis media. Among these there were 18 deaths, a case fatality of 3.18 per cent. Pericarditis was present in 34 cases, 18 of which terminated fatally, with a case fatality of 52.94 per cent. These cases, too, were preceded by pneumonia. Acute endocarditis was recorded in 23 cases, with a case fatality of 34.78 per cent. Eye symptoms are common in measles, and the condition is usually one of catarrhal conjunctivitis, with some photophobia. Phlyctenular keratitis is not an infrequent complication or sequel of measles among children who live in poor hygienic surroundings. It is not commonly seen among the better class of people. Keratitis was recorded in 31 cases.

It has long been considered that measles in some way tends to activate quiescent tuberculosis. Among the total primary admissions for measles, 343 cases of pulmonary tuberculosis were reported, a ratio of 3.66 per 1,000 measles. Among these cases were 31 deaths, a case fatality of 9.04 per cent. Acute miliary tuberculosis was reported in 9 instances and, as usual, terminated fatally.

Francine,[15] at Camp Gordon, Ga., made a statistical review of pulmonary tuberculosis among convalescent measles cases of the 82d Division there. Orders were issued directing that all measles convalescents be examined for pulmonary tuberculosis one month after return to duty from the hospital. As a severe epidemic had occurred, it was possible for the camp tuberculosis and cardiovascular board to examine and follow up 513 cases, which was about one-third of the total that had been discharged from hospital up to that time. Among these cases the lungs were reported as normal in 461, acute bronchitis in 18, clinical evidence of chronic active pulmonary tuberculosis in 16. In other words, of the 513 cases examined, 16, or 3.11 per cent, showed signs of active pulmonary tuberculosis. All of these cases were discharged from the service on surgeon's certificate of disability. Francine compared these statistical data with the results of the tuberculosis board which had examined the entire division. The tuberculosis rate for the division was reported as 0.92 per cent, and it would appear at first sight as if measles had been an important factor in reactivating the old lesions. This is subject to question, as the convalescents were more thoroughly examined than was the division, and the diagnosis in the 16 cases mentioned above was made after more refined and detailed examina-

tion. He concluded that while 3.11 per cent accurately represents the number of cases of active pulmonary tuberculosis in this special group, it is too high if interpreted as an index for measles as a factor in the lighting up of old tuberculous foci.

The findings by Francine are greatly in excess of those reported by Berghoff,[16] at Camp Grant, Ill., after having made a survey of 596 cases to determine the relationship of measles to pulmonary tuberculosis. These cases were first examined 14 days after admission to hospital and again at 30 days or 6 weeks after admission. All of these patients had previously been examined for tuberculosis while in camp during the routine examination. Only three of the convalescents showed unmistakable signs of a recent reactivation of an old tuberculosis directly attributable to measles infection. Of these three cases, one had suspicious findings after the second examination; the second case was a frank reactivation but, upon looking up the records, it was found that he had been under observation for tuberculosis one week prior to admission to hospital for measles; the third case was a frank example of an active pulmonary tuberculosis resulting directly from measles infection. Berghoff concludes that these figures seem to show that measles is not a predisposing factor toward pulmonary tuberculosis.

Whether or not measles predisposes individuals to the occurrence of other exanthematous diseases is not known. Among the primary admissions for measles, scarlet fever occurred as a concurrent disease in 344 cases, diphtheria in 149, erysipelas in 108 and German measles in 38. (See Table 70.) Epidemic cerebrospinal meningitis was concurrent in 93 instances and mumps in 1,028.

Hamburger and Fox,[14] reporting on epidemics of pneumococcus, streptococcus, and measles infections at Camp Taylor, Ky., remarked that these epidemics could be chronologically arranged in five periods. The first, covering September, October, and November, 1917, was designated as the lobar pneumonia period. The second, from November, 1917, to and including January, 1918, was known as the first measles and measles-pneumonitis period. There were 967 cases of measles during this period, 80 of which developed pneumonia and 18 died; the case mortality was 19.4 per cent. Empyema followed measles-pneumonia in 18 cases, with a case fatality of 33.33. The third period, December, 1917, to February, 1918, was designated as the streptococcus atpyical pneumonitis and pleuritis period. Of great interest in this series of cases was the rapid and extensive development of empyema and the presence of hemolytic streptococcus in the pleural exudate. The fourth period was known as the second measles, measles-pneumonia, and streptococcus epidemic. It covered March, April, and May, 1918. During this time there were 414 cases of measles, of which 64 developed pneumonia and 17 died—a case mortality of 31 per cent, as compared with 19.4 per cent in the first epidemic. Empyema followed measles-pneumonia in 15 instances, with a case mortality of 13 per cent. This second measles, measles-pneumonia, and streptococcus epidemic was distinctly more severe than the first epidemic. Patients came into the hospital more acutely ill and prostrated during the latter group and

died in considerably higher numbers. It is also noted that twice the number developed empyema, 3.6 against 1.8 per cent, although the empyema mortality was lower. The reason given for this lower mortality was improvement in the methods of treating empyema. It was noted in the second epidemic that this form of pneumonia and streptococcus sepsis occurred often before empyema had time to develop, and these cases of measles, with associated streptococcus sepsis and a very high mortality, were among the most severe types of disease encountered at Camp Taylor, being comparable only with cases of profound general sepsis and profound toxemia. The fifth period marked the decline of the epidemics and was for May, June, and July, 1918. During this time there were 396 cases of measles, of which 9 developed pneumonia and died. The case fatality was 11.11 per cent. The total number of pneumonias of all classes was 114, of which 8 died, giving a case fatality of 7.9 per cent. The total number of empyemas was 26, with a case fatality of 15.4 per cent. This fifth period is interesting, as it showed marked improvement in morbidity and mortality conditions with the advent of warmer weather, although at no time was the camp entirely free from infection.

As a concurrent disease, measles was reported in 3,714 cases, with 162 deaths. These were admitted to hospital for other causes and the diagnosis of measles was made subsequently. Concurrent with scarlet fever, measles occurred in 114 cases, with 7 deaths; smallpox, 5 cases, no deaths; diphtheria, 23 cases, no deaths; German measles, 21 cases, no deaths; epidemic cerebrospinal meningitis, 32 cases, 17 deaths; mumps, 436 cases, 1 death; pulmonary tuberculosis, 141 cases, 3 deaths; bronchopneumonia 104 cases, 15 deaths; lobar pneumonia, 55 cases, with 5 deaths; influenza, 1,529 cases, with 92 deaths.

During the autumn of 1918, the influenza pandemic period, Sellards,[17] working at Camp Devens, Mass., investigated the occurrence of the influenza bacillus in cases of measles. These studies were conducted immediately after the subsidence of the influenza epidemic, when the Pfeiffer bacillus may have been unduly prevalent. Of the first 31 cases of measles examined, the Pfeiffer bacillus was recovered in 25 during the eruptive stage. Subsequent examinations showed that in three-fourths of these patients the bacillus disappeared with the subsidence of the acute symptoms of measles. A group of control individuals, seven in number, were examined, but no Pfeifferlike organisms were recovered; several reexaminations of the control group resulted negatively. No experimental evidence was obtained to show that these Pfeifferlike organisms have any etiologic relationship to measles.

Bronchopneumonia, the most important of complications, reached its apex of occurrence in January, 1918. The rate declined during February, with a slight increase in March. During 1918, 544 deaths were attributed to this complication. Lobar pneumonia occurred most frequently as a complication in January, following which there was a decline.

An analysis was made of 1,619 clinical records of cases of bronchopneumonia following measles to determine the relationship of such cases to length of service. (Table 71.) Bronchopneumonia was most common among troops with two months' service or less and decreased with each additional month up to and including one year. After that time the number of cases was too small

on which to base any definite conclusions. These same facts apply equally well to deaths. During the first three months of service or less, there were 1,283 of the 1,619 cases and 496 of the 625 deaths; that is, 79.1 per cent of the cases and 79.3 per cent of the deaths. A similar analysis (including 532 cases) was made of lobar pneumonia. (See Table 72.) As with bronchopneumonia, the majority of cases were reported during the first two months of service, and each additional month showed a distinct diminution, not only in cases but also deaths. Of the cases analyzed, 389, or 73.1 per cent, occurred during the first three months of service and 160 of 213 deaths. These occurrences are to be expected when it is seen that measles was most prevalent during the first two months of service, and that it decreased progressively by months thereafter.

TABLE 71.—*Measles with bronchopneumonia. Admissions, deaths, and discharges for disability, by length of service, white enlisted men in the United States, April 1, 1917, to December 31, 1919*

Length of service	Absolute numbers			Percentage rates	
	Admissions	Deaths	Discharges for disability	Case fatality	Case discharges
Less than 2 months	712	298	12	41.85	1.69
2 to 3 months	571	198	11	34.68	1.93
4 to 5 months	196	84	8	42.86	4.08
6 to 7 months	92	32	2	34.78	2.17
8 to 9 months	17	8		47.05	
10 to 11 months	6				
1 year	4				
2 to 4 years	14	5		35.71	
5 to 9 years	6				
10 to 19 years	1				

TABLE 72.—*Measles with lobar pneumonia. Admissions, deaths, and discharges for disability by length of service, white enlisted men in the United States, April 1, 1917, to December 31, 1919*

Length of service	Absolute numbers			Percentage rates	
	Admissions	Deaths	Discharges for disability	Case fatality	Case discharges
Less than 2 months	236	97	5	41.10	2.12
2 to 3 months	153	63	7	41.17	4.58
4 to 5 months	92	33	6	35.87	6.52
6 to 7 months	34	15		44.12	
8 to 9 months	5	3		60.00	
10 to 11 months	3		1		33.33
1 year	2				
2 to 4 years	6	1		16.67	
5 to 9 years					
10 to 19 years	1	1		100.00	

Vaughan,[18] discussing the occurrence of measles in the Army camps during the winter of 1917–18, emphasized the importance of complications. At Camp Cody, N. Mex., among 235 cases of measles, 77, or 33 per cent, developed pneumonia, and 42 per cent died. Not only did measles predispose to pneumonia, but predisposed to a fatal pneumonia. Among each 1,000 men with measles, 44 had pneumonia and 19 died, and of every 1,000 men without measles, 17 had pneumonia and 2 died. Vaughan further remarked that a person who has recently had measles is ten times more likely to die from pneumonia than a person who has not recently had measles.

BACTERIOLOGY OF COMPLICATIONS

The most important bacteria concerned in measles complications during the World War were the streptococcus, pneumococcus, tubercle bacillus, and influenza bacillus. More information is necessary before one can state definitely the relationship that the Pfeiffer bacillus bears, not only to measles but to influenza. The rôle played by the tubercle bacilllus is one of reactivation. It is supposed that measles infection predisposes to the lighting up of old tuberculous processes, especially of the lung. The relationship of the streptococcus and pneumococcus in measles had been under investigations for many years, but interest in this subject was increased by the widespread occurrence of measles and its complications in the Army during the war.

Inflammation of the respiratory tract during an attack of measles readily permits the invasion of pathogenic bacteria. Irons and Marine,[19] at Camp Custer, Mich., made important observations showing that the hemolytic streptococcus had been the principal cause of bronchopneumonia outbreaks following measles in the military camps. Cole and MacCallum[20] reported, during their investigations at San Antonio, Tex., that the *Streptococcus hemolyticus* was present in cultures of sputum coughed up from the deeper parts of the respiratory tract in 30 cases of post-measles bronchopneumonia, and mice, inoculated with sputum from 17 cases, yielded the streptococcus in 16. Blood cultures taken during life yielded the *Streptococcus hemolyticus* twice in 15 cases. Of the 30 cases, death occurred in at least 14, and in all the *Streptococcus hemolyticus* was found in the lungs in practically pure cultures. The abdominal organs were found to be free from streptococcal invasion; however, areas of interstitial bronchopneumonia were characterized by streptococcal bronchopneumonia with the streptococcus present in the pleural exudate. In the purely lobular pneumonia areas they were present in amazingly large numbers. According to Hektoen,[21] measles patients seem to become infected with hemolytic streptococci by direct droplet infection, contact, and dust infection by way of the throat; the infection also appears to spread more easily in military camps and in measles wards. Irons and Marine [19] found that the *Streptococcus hemolyticus* developed in the throat cultures of approximately 70 per cent of healthy soldiers during a period of respiratory infections. Cumming, Spruit, and Lynch [22] reported that, while 35 per cent of measles patients had streptococci in the throat, this was the case in only 6 per cent of healthy soldiers. Cole and MacCallum [20] found that 56.6 per cent of the patients in a measles ward harbored the *Streptococcus hemolyticus* in the throat, as compared with 21.4 per cent in a suspect tuberculosis ward. They also found the *Streptococcus hemolyticus* in throat cultures of 11.4 per cent of measles patients on admission to hospital; after a duration of from 3 to 5 days in the ward, the per cent increased to 38.6, and after 8 to 16 days to 56.8 per cent. These observations, according to Hektoen,[21] point unmistakably to the ease with which the *Streptococcus hemolyticus* passes from carrier to noncarrier and, in measles convalescence, sets up broncho-pneumonia and empyema.

Levy and Alexander,[23] discussing the susceptibility of measles convalescents to streptococcus infection at Camp Taylor, Ky., showed that complications and sequelæ were responsible for long hospitalization and high noneffective rates.

A careful study was made of 388 cases. On admission to hospital, all cases were sent to a special ward where they remained in bed, and from them daily cultures were made for the streptococcus. Carriers of this organism were placed in "dirty wards," or wards where patients were known to be infected with this organism. Patients with negative throat cultures were held for a second examination. If negative on the second examination, such cases were transferred from the observation ward to "clean wards." Cultures were taken from the tonsils and pharynx and plated on human blood agar; bronchial cultures were made when possible. The results of bronchial cultures conformed to those of the throat cultures, therefore the former furnished no special information. Of the total cases examined, 89 or 22.9 per cent were noncarriers and 299 or 77.1 were found to be carriers. This is in marked contrast to the San Antonio findings, where only 11.4 per cent of measles cases were reported as carriers of the *streptococcus hemolyticus*.[20] At Camp Taylor, Ky., the investigators found that of the noncarriers, 27 became carriers while in hospital, and of the 388 cases studied, 119, or 30.6 per cent, developed complications; of the latter, all except 4 were among noncarriers.[23] The complications that developed in the noncarriers were acute tonsillitis, 1 case; acute bronchitis, 2 cases; cervical adenitis, 1 case. Among the carriers, 47 developed bronchopneumonia, 22 otitis media, and 15 empyema. That is, complications developed in 36.8 per cent of carriers and 6.4 per cent of clean cases; or 12.1 per cent of all cases developed bronchopneumonia, of which 34 per cent developed empyema.

During the winter of 1917–18, Camp Taylor was heavily infected with the *streptococcus hemolyticus*, and almost every organization had representatives in hospital that showed this organism. Of the 388 cases studied by Levy and Alexander[23] at Camp Taylor, Ky., 346 were from the depot brigade, which was composed principally of troops recently arrived in camp. One company of 95 men was examined and 83.2 per cent were found to be carriers. Men composing one draft assigned to Camp Taylor were examined to demonstrate whether this high carrier rate occurred in camp or was imported. To accomplish this end, 489 new recruits were examined as they stepped from the train. The result of this examination showed that 14.8 per cent harbored the *Streptococcus hemolyticus;* therefore, it was concluded that the men were also acquiring the carrier state in the camp.

According to Capps,[24] at Camp Grant, Ill., where more than 900 cases of measles occurred during the winter 1917–18, only 20 developed bronchopneumonia, most of which were of streptococcal origin. As a primary infecting organism in the causation of respiratory infections in our home camps, the streptococcus had a formidable record; but as a secondary infection, especially in pneumonia and measles, this organism was more dangerous than all others put together.

Clendening[25] studied the incidence of *Streptococcus hemolyticus* infection in lobar pneumonia following measles and scarlet fever at Fort Sam Houston, Tex. To the base hospital there, from December 1, 1917, to March 1, 1918, 319 cases were admitted as primary lobar pneumonia, 44 of which became reinfected with the *Streptococcus hemolyticus*. And among 97 cases of empyema, with 32 deaths, 18 were due to the streptococcus. During this same period,

there were 716 cases of measles, among which were about 150 cases of otitis media, 89 cases of bronchopneumonia, 12 cases of articular rheumatism, and 2 cases of meningitis with general sepsis. All were ascribed to the streptococcus. Knowlton,[26] working at the base hospital, Camp Jackson, S. C., reported the results of routine throat cultures from October, 1918, to May, 1919, when measles cases were examined to determine what part the *Streptococcus hemolyticus* played. There were 458 cases of measles in an eight weeks' period which ended December 13, 1918. Postnasal cultures were taken in these cases. The percentage of positives varied materially in different weeks; the lowest was 19 per cent in the fourth week and the highest 45 per cent in the eighth week. The percentage also varied in different wards, the highest being in a ward where cubicles were not at first used. A special study was then made to determine what part the streptococcus played in complications. Among 458 cases of measles there were 13 deaths, or 2.7 per cent case fatality; 48 of the cases developed pneumonia, of which 10 showed empyema, with the *Streptococcus hemolyticus* as the predominating organism. Six deaths occurred among these empyema cases. There were 43 cases of suppurative oditis media, 5 of which developed mastoiditis. Knowlton found that pneumonia and otitis media occurred in the same proportion of patients whose throat cultures showed the streptococcus as among those whose cultures were negative. Of 458 throat cultures, 122 were positive and 336 negative. Cases with pneumonia as a complication were positive in 10.6 per cent. The cases with otitis media as a complication were positive in 9 per cent and negative in 9.8 per cent. He concluded that there was no relation between the presence of the *Streptococcus hemolyticus* in the throat and the occurrence of complications of measles.

In an investigation of the occurrence of the streptococcus in the throats of measles patients on admission to the hospital at Camp Pike, Ark., during September and October, 1918, the following data were obtained:[27]

	Number of measles patients whose throats were swabbed	Number harboring hemolytic strepto-cocci	Per cent harboring strepto-coccus
On admission	598	15	2.51
After 1 week in hospital	359	14	3.9
After 2 weeks in hospital	170	17	10.0
After 3 weeks in hospital	41	9	22

The incidence of the *Streptococcus hemolyticus* in the throats of patients admitted to hospital with measles was comparatively low. With progress of the disease, as measured by the length of stay in hospital, the proportion of patients harboring the streptococcus gradually increased.[27]

DIAGNOSIS

The diagnosis of measles is dependent upon clinical manifestations. No known serological or bacteriological findings are of diagnostic importance. These facts were known before the war, and experience gained during the war furnished nothing worthy of special mention. Although a common disease,

and in its characteristic form readily recognized not only by physicians, but also by the laity in the vast majority of instances, there are cases where differential diagnosis is difficult and may lead to error. This undoubtedly accounts for the majority, if not all, of the so-called recurrent attacks of measles. The confusion with smallpox, so often spoken of in ancient writings, is not a matter of great concern at present, at least it did not exist in the Army during the World War.

The prodromal scarlatinal type of rash may lead to the diagnosis of scarlatina, and vice versa, when patients are admitted to hospital in this stage of measles. The diagnosis of scarlet fever may be made and later the typical clinical picture of measles may develop, thus leading not only to confusion, but also to an additional diagnosis. This in all probability, accounts for some of the cases reported as a double infection of measles complicated by scarlatina, or vice versa.

The somewhat similar nomenclature of measles and German measles is based upon clinical manifestations and not upon the etiology. These conditions are recognized as distinct and separate diseases, the points of differentiation being mentioned in the chapter on German measles. The necessity for a differentiation between these diseases is not uncommonly encountered; statistics from Camp Lewis, Wash., and possibly those from Camp Cody, N. Mex., during the last four months of 1917, indicate that medical officers on duty in those camps experienced some difficulty. During this period extensive epidemics of measles prevailed in the Army camps throughout the United States. The general health of Camp Lewis remained good during the latter months of 1917 except for an outbreak of German measles.[28] By December, this disease had reached epidemic proportions and 1,000 cases were reported sick during that month. Meanwhile, there was very little plain measles; however, as the epidemic of German measles died away, true measles became commoner and rose to about 200 admissions per month. Indeed, for a time in the spring of 1918, Camp Lewis had more true measles than any other camp in the United States save Camp Cody.[28] The significance of the apparent substitution of German measles for true measles at Camp Lewis in the early winter of 1917–18 remains unsolved. During 1917, there were 9,244 primary admissions for German measles, Camp Lewis furnished 1,548 and Camp Cody 1,351. During this time, Camp Lewis reported 164 primary admissions for measles and Camp Cody 337. In view of the extensive occurrence of measles in other Army camps and the comparatively minor occurrence of German measles, it would appear that the diagnosis of these two diseases was confused in the two camps above mentioned.

PROGNOSIS

There appears to be no reason to believe that measles per se resulted in death or permanent disability during the war. The prognosis of this disease is the prognosis of its complications. Further, measles offers favorable conditions for the development of the pneumococcus and opens the doors to the streptococcus, the organisms that were most destructive to life and left more permanent disability in their wake among soldiers than all other known germs. It is generally accepted that the death rate is higher among measles cases

treated in hospitals than in those treated in private homes. This is due to cross infections resulting in complications that may be increased by faulty technique, faulty hospital construction for isolation, careless attendants, poor ventilation, and overcrowding in hospitals. Conditions are most favorable for fatal pneumonia epidemics in military camps when the disease appears during cold weather and when virulent pneumococci and streptococci are prevalent. These conditions existed in the fall and winter of 1917–18.

There were 2,370 deaths recorded among the primary admissions and 162 among cases in which measles was a concurrent disease. The case fatality was 2.4 per cent among the former. One hundred and forty-nine men were discharged from the Army on account of permanent disability following admission to hospital for measles. The majority of these cases suffered from disabilities directly attributable to pneumonia and its complications. More than 22,000 complications were reported among the primary admissions for measles. When viewed from this standpoint, it is seen that the prognosis was not so favorable in the Army as is generally accepted among the civil population.

PREVENTIVE MEASURES

The virus of measles is contained in the nasopharyngeal discharges and in the blood at an early stage of the disease. Thus communicability begins, certainly, before the appearance of the exanthem and in all probability before the Koplik spots; it may exist, at least to some degree, from the very beginning of the infection. Efforts to prevent spread from the respiratory system led to the system of isolation, the use of sputum cups, cubicles for patients, gowns and masks for attendants, and such terminal disinfection as was used during the World War.

Appreciating the value of immunity conferred by previous attacks for purposes of quarantine, Munson,[29] in 1916 caused a census to be taken at Camp Wilson, Tex., to determine from the statements of the soldiers whether or not they had previously had measles. With this information as a basis of quarantine for contacts, along with avoidance of overcrowding in tents, the sunning of bedding and personal effects, and with proper ventilation of sleeping quarters, outbreaks of measles at Camp Wilson were brought under control. Munson held that measles epidemics are preventable. He recognized that a census, based upon the soldiers' statements, is only approximately correct; however, it is sufficiently accurate for practical purposes, and the error lies largely in the direction of the soldier reporting a previous attack of measles when he really never had it.

Sellards[30] reported on a census of susceptibility to measles and its relation to quarantine procedures at Camp Meade, Md. This census differed from that reported by Munson,[29] as the statement of each soldier was checked by a written report from his parents. Discrepancies were numerous and were almost entirely in the direction of the soldier having altogether forgotten attacks of measles that occurred in early life. To avoid prejudicing him, the soldier was given a card to complete, which showed not only measles but also scarlet fever, German measles, and meningitis. In 144 statements of soldiers claiming measles, the parents confirmed them in 133. In 89 cases where soldiers reported

no measles the parents confirmed them in 49. This shows the greater portion, 92 per cent, of answers indicating a previous attack was confirmed by the parents, while, of those indicating that no previous attack of the disease had occurred, 55 per cent were not confirmed by statements of the parents. Sellards obtained similar results in a census at Camp Devens, Mass.[31] These results introduced an element of doubt into some of the conclusions drawn by Munson, since the number of measles cases developing at Camp Wilson, Tex., was only one-fifth of the entire number reporting themselves as susceptible. Munson concluded that the preventive measures probably protected four-fifths of the supposedly susceptible men, while of the 89 men at Camp Meade reporting themselves as susceptible, more reliable information from the parents indicated susceptibility with reasonable certainty in 22, or one-fourth of the number.

A measles census was taken at Camp Pike, Ark.,[32] and the results attained are rather striking. It was found that 61.5 per cent of the white recruits were classified immune and 38.5 as nonimmune. Approximately 30,732 immunes furnished 44 cases of measles, or 1.4 cases per 1,000 strength, while approximately 19,261 nonimmunes furnished 956 cases of measles, or 49.6 cases per 1,000. It was reported that the infrequency of measles among the men classified as immunes had been of great assistance in the selection of men for shipment to other camps and to ports of embarkation. Although, as shown above, there was some discrepancy relative to the value of a measles census, this information, when it is practicable to obtain it, is of great value in dealing with outbreaks of the disease.

Gittings [33] reported on the military value of the immunity conferred by previous attacks of measles, scarlet fever, and mumps at Camp Mills, Long Island. In the fall of 1917, both measles and German measles were epidemic at that camp; and as patients were questioned on admission to the camp hospital, it was very noticeable that those suffering from German measles almost invariably gave a history of having had a severe attack of true measles, while those with measles denied ever having had a previous attack or admitted having had it only in a mild form. So noticeable was this that it became a factor of distinct importance in determining the diagnosis in early doubtful cases and often formed the basis for isolation into one or the other groups. Subsequent developments almost invariably substantiated the history. Commenting on the value of previous attacks of measles at the United States Army General Hospital No. 9, Lakewood, N. J., Gittings stated that the observations made at Camp Mills were corroborated. These observations were based upon an analysis of 100 Hospital Corps men transferred from Camp Greenleaf, Ga. From them it was concluded that immunity conferred by previous attacks of measles, German measles, scarlet fever, and mumps should be recorded on the service record of the soldier at his first physical examination and that subsequent attacks while in the service should be recorded, as this information possesses practically the same significant value as does the record of typhoid and smallpox prophylactic vaccinations.

Previous to the World War numerous investigators attempted to produce active or passive immunity in measles. Various methods were employed and favorable results reported in some instances. In so far as passive immunity is

concerned, Sellards,[31] working at Camp Devens, used blood from active cases of measles on two volunteers to test their susceptibility to measles. These men were exposed to a child in the preeruptive stage and were also thoroughly inoculated over the mucous membranes of the eyes, nose, and throat with mucous secretions from this patient. They developed no symptoms of the disease.

Attempts at the production of active immunity, not only against measles itself but against some of its more important complications, were attempted in the camps during the war. MacCallum,[34] in 1918, stated that in order to prevent the extensive occurrence of measles among the troops quarantine methods or some form of prophylactic vaccination might be feasible. Several months prior to this, it was reported from Camp Pike,[35] investigations were begun on a vaccine made of the Tunnicliff coccus. The original plan was to secure complete statistics on the vaccination of 2,000 men. Soon after this work began, 1,350 of the 1,500 men who had received the first inoculation were transferred to Newport News, Va., thus making complete inoculations and observations impossible. These were casual troops and had repeatedly been exposed to measles. Four cases developed among the 1,350 men who had received the inoculation, and 16 cases developed among 1,500 others in the same depot who had not been vaccinated. Following the above-mentioned transfer, 500 men were given the first and second inoculations seven days apart. Two cases of measles developed among them between these inoculations. During the same period 15 cases developed among uninoculated troops. Before a third inoculation could be accomplished all but 146 were transferred. The 146 received a third inoculation and, in so far as was known, none developed measles. At the conclusion of these observations, 176 men had received the third injection. Among these there were 2 cases of measles. The experiments were not considered complete or conclusive, but it was the impression that the vaccine produced some immunity, and pneumonia, as a complication, seemed to have been less common.[35]

Coincidentally with attempts to treat measles at Camp Gordon, Ga., it occurred to the chief of the medical service there [36] that it would be advisable, on account of the dangerous complications, to make some attempt to immunize measles cases against streptococcus infection. A vaccine was prepared with this in view, using various strains of streptococci obtained from the pleural cavity, heart's blood, lung, pertioneum, and cases of empyema. A series of 100 measles cases was used for these observations, 50 receiving the vaccine and 50 being used as a control. The vaccinated cases were given three injections at five-day intervals. Both test and control cases were kept under identical conditions. Of the 50 cases so vaccinated, 2 developed streptococcus bronchopneumonia, and of the 50 control cases, 14 developed streptococcus bronchopneumonia or empyema. These results were considered sufficiently satisfactory to warrant its continuance at Camp Gordon, and conclusions were drawn that while there were from time to time cases of streptococcic empyema and pneumonia following measles, the condition no longer presented the menace to life and health which it had during the winter months.

Munson,[29] in 1916, reported the prevention of measles at San Antonio, Tex., by requiring frequent medical examinations; the isolation of all suspects

until a definite diagnosis could be made and of susceptible contacts for 14 days; the establishment of sanitary regulations to prevent the transmission of the virus from soldier to soldier; the regulation of places of amusement and recreation; the furling of tents to expose bedding and clothing habitually to the sun and air for at least two hours daily; the prohibition of the common drinking cup and of the practice of spitting in the barracks; the use of the measles census. All of these methods were employed during the war, but without accomplishing the results reported by Munson.

As previously stated, during the fall of 1917 incoming troops were assigned directly to organizations without a period of detention.[7] As soon as practicable incoming troops were assigned to organizations or placed in separate detachments, quarantined with the organization but in separate barracks for a period of 14 days. Daily examinations were made for the detection of contagious diseases during that period. After the first 32 divisions had been organized, incoming troops were assigned to a separate organization, the depot brigade which, at times, aggregated more than 10,000 men per camp.[7] Segregation was attempted in the depot brigade as far as sleeping quarters, mess, and drill were concerned. In some instances, troops were held in more or less effective quarantine for the expiration of two weeks, but generally speaking they intermingled with other members of the camp during recreation and amusement. This method was an improvement over the assignment direct of incoming troops to permanent organizations; but the depot brigade existed for the purpose of preliminary training for and supplying troops to the division of the camp of which it was a part, and the prevention of the spread of the contagious diseases was not its prime function.

In the summer of 1918, detention camps were authorized for the large cantonments.[37] It was contemplated that all incoming troops would first pass through these detention camps where contagious diseases would be detected, patients isolated, and the command thus kept reasonably free. The armistice was signed before these detention camps were completed.

In some camps a rapid examination of incoming men was made at the railroad station and suspicious cases were segregated.[7] Quarantine was operated in some, by organizations in which measles occurred. In some instances whole companies were quarantined for 14 days; however, in most instances only immediate contacts were quarantined. Where a command was known to be infected, daily examinations of the entire command were made by medical officers, throats sprayed, and precautions taken to provide good ventilation and the best feasible separation of men at night.[7] Cubicles were installed in some barracks, use being made of the shelter half as the means of separating adjacent beds; special local regulations were issued against spitting, and soldiers were cautioned against the dangers of coughing and sneezing while in the vicinity of others; alternate head and foot sleeping was ordered and enforced during the latter part of the war.[7] Dust from roads and walks was looked upon as a predisposing cause, not only in measles, but also in other infectious diseases; hence roads were sprayed with oil in some camps, with apparently good results in the southwestern camps.[7]

The proper heating and ventilating of barracks were given serious consideration. Heating was difficult, particularly in the fall of 1917, as many of

the heating systems were incomplete.[7] Many of the barrack buildings were heated with stoves and soldiers habitually congregated around them, thus increasing the dangers of droplet infection. Orders were issued in an attempt to prevent this.[7] With inadequate heat it was difficult and at times impossible to enforce regulations for ventilation, so night inspections were commonly made by company and regimental medical officers to enforce this order.[7]

Contact with civilians was thought by some medical officers to be a cause of introducing measles into camp. However, in the American Expeditionary Forces, Emerson [10] found no evidence that infection was transmitted from the civilian population to members of the American Expeditionary Forces; no epidemics occurred after the armistice began, and most of the cases that did occur were reported from the armies in the advance section. Many medical officers felt that, owing to the ease with which the infectious agent of measles could be transmitted from person to person and to the high susceptibility of the nonimmune, any real effort to prevent the infection was more or less futile.[10]

In general, upon the detection of measles the patient was sent by ambulance to the hospital for segregation, observation, and treatment.[7] In the early part of the war, little or no attention was paid to the possible spread of infection while en route to hospital, although these patients at times were dispatched in the same ambulance with others. After the use of the face mask at Camp Grant, Ill., in the fall of 1917 [38] was reported, this means of preventing the spread of infection was applied to patients in the regimental infirmaries and in ambulances. An order was issued that all patients suspected of having an affection of a respiratory nature should be masked until arrival in the proper ward at the hospital.[39] As the war progressed and more experience was acquired, every effort was made to prevent the spread of infection from the time the patient was detected until arrival at his bed.

It has been the practice in military as well as in civil hospitals to segregate patients with measles from those suffering from other diseases. This was the aim during the war; however, the vast majority of cases were received at the military hospitals during the second stage of the disease and had had ample opportunity to spread the virus to others before arriving at the receiving ward. Once received, they were placed in specially designated wards, where the attendants wore gowns and masks, and where sputum cups, special dishes, and thermometers were provided for these patients.[40] The linen was sent to disinfectors as soon as these appliances became available. In October, 1917, the base hospital, Camp Grant, Ill., in an effort to prevent droplet infection, established the plan of masking measles patients and isolating them by means of cubicles, formed by sheets suspended on transverse and longitudinal wires stretched across the ward.[41] As stated above, these preventive measures were received with favor and soon adopted throughout the Army.[40] The paper sputum cup was later supplemented by the paper bag and paper napkin as receptacles for nasal discharges. These were collected at regular intervals and burned. It was realized that separate rooms would be better than wards for measles patients but this was not possible on account of the number of cases. Such practice would also have called for considerable additional personnel, which was not available. In fact, the hospitals were not constructed with any such practice in view.

During the latter part of 1917, the problem that confronted the hospital was the actual care of measles in its acute stages. In December, this problem became more difficult on account of the pulmonary complications—principally pneumonia of the pneumococcus type. In the early part of 1918, the type of pneumonia, generally speaking, became the streptococcus type, many cases of which were followed by empyema. It was realized that measles infection lowers the resistance and predisposes the individual to a great variety of other infections and that the mortality depends largely on the occurrence of secondary infections which accompany or follow the primary disease. The attention of medical officers in the field, therefore, was directed to the prevention of these secondary infections.[40]

Inasmuch as base hospitals could control the patients only from the time they were received in the hospital, the success of isolation depended on the percentage of secondary infections acquired after their admission. Levy and Alexander [23] recommended that all new measles patients be held in segregation until identified as clean cases or carriers and then be assigned to wards accordingly. In one ward with 15 clean cases quartered with 15 contaminated cases, it was found, at the end of one week, that only 6 noncarriers remained. In another ward of 24 patients, of whom 12 were carriers, only 3 remained clean at the end of a week. Thus they showed that clean cases became contaminated when the ward was mixed. During another observation it was found that where proper segregation was maintained, strictly clean wards remained clean. They concluded that if the incidence of complications in measles is to be reduced, carriers must be separated and cared for in different wards. Lynch and Cumming [42] believed that the air-borne or respiratory diseases are essentially hand-to-mouth infections and that measures applied to prevent this will enormously reduce their occurrence. Friedman and Vaughan [43] remarked that in considering the prevention of measles complications, while emphasis was rightly laid on direct transmission through droplet infection, the indirect means through attendants, utensils, etc., was being unduly neglected. They recommended cubicles of a more substantial nature than sheets: A wooden frame 8 feet long, 6½ feet high, with a sheet or canvas tacked across it. This device rested on 18-inch bases and was placed between adjacent beds. Further, these authors treated cases at Camp Sevier, S. C., as bed patients until considered safe as to carriers by the ward surgeon. A gown was permanently kept in each cubicle and worn by every individual who entered. Individual thermometers, wash cloths, basins, towels, and glasses were kept in each cubicle. The dishes were soaked in lye solutions and then washed in hot water; bed pans and urinals were washed in water immediately after being used and then placed in large galvanized iron cans containing lye solution; medicine glasses, syringes, and ice bags were sterilized after use; the water taps and basins in the bathrooms were washed with lye solution. The number of cases reported by these authors is too small to base definite conclusions on; however, the above mentioned technique would be difficult to carry out in military hospitals and would require considerable additional equipment and personnel. Nevertheless, vigilance and discipline can do much toward controlling measles.

Clendening's [25] plan was to segregate every case of pneumonia, measles, and scarlet fever for 24 hours, during which time throat cultures were made

and examined. The disposition of the case then was determined upon by whether or not the streptococcus was present. It was claimed that the incidence of bronchopneumonia was greatly reduced by this method.

In many, if not in all, of the camps the *Streptococcus hemolyticus* was found associated with many cases of pneumonia that complicated measles; it also occurred to a variable extent independently. This organism was found in the throats of patients suffering from measles and in contacts, as well as in the throats of soldiers chosen at random. Whether it was brought by carriers or disseminated through the camp can not be stated; however, there are reasons to believe that such diseases as measles and influenza and the time of year, such as the winter season, played an important part. Otherwise there would have been outbreaks of pneumonia due to this organism as soon as the troops reached camp, which was not the case.[44] In addition, there would have been no such clear connection between the measles curve and the pneumonia curve as was the case. Further, the principal outbreaks of pneumonia would not have developed in winter and would not have terminated abruptly in the spring.

The camp epidemiologist, Camp Pike, Ark., in a special report on measles at that place, stated that owing to the crowded condition in the base hospital during the fall of 1917 measles cases were treated in barracks set aside for that purpose in each organization area.[45] This report was based upon the comparative results between 538 cases treated in the base hospital and 256 treated in barracks. Among the former, 51 developed complications, of which 30 were pneumonia, with 11 deaths. Among the latter, 4 developed complications, 2 of which were pneumonia; in addition, there was 1 death following the complication of otitis media. In other words, 9.5 per cent of the hospital cases and 1.6 per cent among those in barracks were complicated by other diseases. The death rate among the former was 2 per cent and among the latter 0.4 per cent. These figures are small but significant. The essential differences in the care of these cases were: More space afforded cases treated in barracks than in hospital; the liability to cross infection was greatly reduced among the barracks cases, though nursing facilities were practically nil there, with the exception of orderlies to care for the food and excretions of the patient.

When patients are out of bed and able to go about the ward, when they come in close contact with others, the danger of the transfer of measles has passed. However, the danger of transfer of secondary infecting agents often is still present. The danger of spreading secondary infection during convalescence may be removed, to a great extent, by wearing gauze masks over the mouth and nose. This became a common practice after the dangers of cross infection were more fully recognized.

During the major portion of the first year of our participation in the war, the men were sent to duty when the temperature had returned to normal, desquamation was completed, and the physical condition was apparently good. The duration of hospitalization in many instances was also abbreviated as far as possible on account of the urgent need for additional beds. This practice led observers to believe that complications occurred and that patients were sent to duty before their physical condition justified it. As a result, the Surgeon General issued instructions that all convalescent measles patients would be held

in hospital, or under observation, for at least two weeks after the temperature had returned to normal.[40] Although there are no statistics available to show the value of this order, it is the consensus of opinion of medical officers that it measurably reduced the number of complications and deaths.

Room disinfection following measles was not a routine practice in the Army even at the outbreak of the war. It was used in isolated cases, but, in so far as the records show, it fell into disuse as being of no value. The larger hospitals were provided with steam disinfectors for the sterilization of wearing apparel and bedding.[46] These appliances had a capacity of 30 to 40 mattresses. Pillows, blankets, and mattresses were disinfected, at times, after measles, but not as a routine.[7] The general practice was to send them to the disinfector when they were macroscopically soiled. Linen from the contagious services was run through the disinfector before being sent to the laundry, when time and opportunity were available. In isolated instances, following outbreaks of measles, regimental surgeons sent the blankets and mattresses of entire companies or detachments to the hospital for disinfection.[7] This, too, was not a routine practice, and there is nothing in the records to indicate that it had any influence in controlling the disease.

While the measles virus is short-lived outside of the body and is killed readily by exposure to sun and air, this is not true to the same degree of organisms causing secondary infections. Bacteria causing the latter may retain their vitality and pathogenicity for a long period after mucus secretions which contain them have dried. It was along these lines that terminal disinfection, as applied to bedding, linen, floors, and mess equipment was considered of special value.

TREATMENT

The general care of measles patients during the World War was that of other infectious diseases. The uncomplicated case required no special treatment. The treatment of measles carried out in the base hospital at Camp Jackson, which may be taken as the usual treatment used throughout the Army, follows:[47]

> There were no striking developments in the treatment of measles during the war. Various methods were employed in attempts to minimize complications, but none of them was conspicuously successful, and until the causative agent is identified and a potent protective serum developed, there is little hope there will be any brilliant progress in treatment. In general, treatment was directed toward keeping patients as comfortable as might be, supporting the strength, aiding elimination, and an effort to prevent intercurrent respiratory complications. Many different methods to these ends were employed and the details varied somewhat in each hospital, and at times in each ward. However, disturbing patients to administer some drug which, theoretically, would prevent some possible complication or be given as a placebo was not justified by the results obtained. Procedures which promised well during the early trials were found valueless when given the test on a larger series of cases.

The treatment at Camp Jackson which seemed to give most comfort to the patient was briefly as follows:[47]

> The wards were kept well ventilated but not allowed to become cold, as cold air always increased the amount of coughing. It was not necessary to darken the wards; however, patients were shielded from direct sunlight and those with marked photophobia were removed to the darker parts of the ward. Artificial lights were carefully shaded and patients with annoying cough were grouped, as far as possible, at one end of the ward to minimize the

disturbance that they caused to others. Laxatives were given routinely on admission and aspirin for headache if necessary. Patients were encouraged to drink water freely. The diet was found to be practically self-regulating, and during the period of high temperature there was little or no desire for food, so liquids were practically the only form of nourishment taken. If vomiting developed, all food was withheld until it ceased, which usually occurred in 24 hours. There was much less nausea among patients so treated than among those given food during the period of nausea, and the period of starvation was so short that it did not impair the patient's strength. When nausea ceased, the patient was then allowed a general diet. Mastication aided in keeping the mouth and tongue clean and stimulated gastric digestion; liquids and soft diets all tasted alike to the patient with a foul mouth, while solid foods well seasoned were apt to be fairly palatable and when taken in larger amounts maintained nutrition at a higher level. This point was important to a patient facing the possibility of pneumonia, or some other serious disease, as a late complication. Not only was his resistance to infection greater, but his recuperative power, if infection occurs, was superior to that of an undernourished individual.

Cough was often a troublesome symptom, preventing sleep alike to the individual and his neighbors. Cold air greatly aggravated it, as shown by the amount of coughing at night compared with the day. It was often the custom to open ward windows at night, with a distinct lowering of the room temperature and increase in the amount of coughing. To keep the ward warm at night as well as in the day lessened cough demonstrably. For the measles patient whose cough is due to inflammation of the upper respiratory passages, warm air is a necessity. When cough was not controlled by temperature and moisture of the room, opium was used either in the form of codein by mouth or morphia hypodermically.

As stated above, many attempts were made to prevent the development of upper respiratory complications. Germicidal solutions were used as a spray without success, patients washed their mouths and gargled with a bland alkaline solution twice daily when they brushed their teeth, vaseline containing some menthol was used for local discomfort in the nose, while liquid albolene was used if the mouth was sufficiently dry to cause discomfort. There was nothing to indicate that spraying was of value and the other forms of treatment enumerated were entirely symptomatic. Special attention was paid to the detection of complications in their early stages, and when detected the treatment was that of the complication in question. Otitis media, especially if due to the *Streptococcus hemolyticus*, developed with surprising rapidity, and rupture of the drum membrane was observed at times in a few hours after the onset of pain. Early paracentesis was necessary for treatment and the prevention of mastoid involvement. Meningitis appeared to assume its most fulminating form when it developed during measles.

It was recognized early during the war that measles patients who developed pneumonia should be isolated in wards specially designated for that purpose, as they were a potential source of infection for others. Therefore measles pneumonias were cared for separately and not allowed to remain with uncomplicated measles or cared for in wards where primary lobar pneumonia or bronchopneumonia cases were. Some camps, as a routine, examined all measles admissions for streptococcus in throat smears, and when found the patients were assigned to separate wards.

Treatment of the carrier state (streptococcus) was disappointing. Levy and Alexander[23] reported that throat cultures made at intervals in many of the "dirty" wards showed that the carrier state, once acquired, persisted throughout the patient's stay in hospital and exceptions to this rule were rare. Attempts were made at mouth disinfection without success. Neutral solutions of chlorinated soda in half strength, which had been in common use as a gargle and spray in many Army hospitals, will not kill the *Streptococcus hemolyticus* even in vitro; while experiments with other mouth antiseptics, notably iodine in glycerin, though successful in the test tube, were clinically disappointing. Of the patients discharged from the hospital at Camp Taylor, who during their stay in the institution were proven to be carriers of the streptococcus, 71.7 per cent, in spite of treatment, still harbored the organism upon return to duty.

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56706—28——29

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CHAPTER XIII

MUMPS [a]

STATISTICAL CONSIDERATIONS

Table 73 shows that 230,356 cases of mumps were admitted to hospital for the total Army during the World War, giving a ratio of 55.80 per 1,000 strength. Among white enlisted men there were 179,948 primary admissions, with a ratio of 49.99 per 1,000 per annum; colored enlisted men had 38,619 primary admissions, with an admission ratio of 134.75 per 1,000 strength, three times that for the white troops.

During the World War 43 white enlisted men and 7 colored enlisted men were discharged from the service on account of disability following mumps. The discharge ratios per 1,000 strength were 0.01 and 0.02, respectively. The discharge ratio for colored enlisted men, was twice that for the white. In explanation of these discharges, it is most probable that there were factors causing disability in these cases other than mumps.

Because of the nonfatal character of mumps, its great importance to the Army is shown more particularly by the number of days lost from duty. For the total Army 3,884,147 days were lost from duty on account of this disease, giving a noneffective ratio of 2.58 per 1,000 strength. From a standpoint of noneffectiveness, mumps stood third on the list of important diseases for the Army; therefore, when compared with other diseases, and from a standpoint of noneffectiveness alone, mumps was of great importance.

TABLE 73.—*Mumps. Admissions, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919*

	Admissions			Discharges for disability		Days lost	
	Total mean annual strengths	Absolute numbers	Ratio per 1,000 strength	Absolute numbers	Ratio per 1,000 strength	Absolute numbers	Non-effective ratios per 1,000 strength
Total officers and enlisted men, including native troops	4,128,479	230,356	55.80	52	0.01	3,884,147	2.58
Total officers and enlisted men, American troops	4,092,457	229,680	56.12	52	.01	3,874,722	2.59
Total officers	206,382	2,475	11.99			37,713	.50
Total enlisted American troops:							
White	3,599,527	179,948	49.99	43	.01	3,020,897	2.30
Colored	286,548	38,619	134.75	7	.02	656,383	6.28
Color not stated		8,638		2		159,729	
Total	3,886,075	227,205	58.47	52	.01	3,837,009	2.71
Total native troops (enlisted)	36,022	676	18.76			9,425	.72
Total Army in the United States including Alaska:							
Officers	124,266	1,648	13.26			24,447	.54
White enlisted	1,965,297	117,498	59.78	35	.02	1,877,193	2.62
Colored enlisted	145,826	22,482	154.15	7	.05	374,904	7.04
Total enlisted men	2,111,123	139,980	66.31	42	.02	2,252,097	2.92
Total officers and men	2,235,389	141,628	63.36	42	.02	2,276,544	2.79

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

TABLE 73.—*Mumps. Admissions, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919*—Continued

	Admissions			Discharges for disability		Days lost	
	Total mean annual strengths	Absolute numbers	Ratio per 1,000 strength	Absolute numbers	Ratio per 1,000 strength	Absolute numbers	Non-effective ratios per 1,000 strength
U. S. Army in Europe, excluding, Russia:							
Officers	73,728	773	10.48			12,531	.47
White enlisted	1,469,656	57,554	39.16	6	0	1,063,930	1.98
Colored enlisted	122,412	15,023	122.72			267,234	5.98
Color not stated		8,503		1		157,527	
Total enlisted	1,592,068	81,080	50.93	7	0	1,488,691	2.56
Total officers and men	1,665,796	81,853	49.14	7	0	1,501,222	2.47
Officers other countries	8,388	54	6.44			735	.24
U. S. Army in Philippine Islands:							
White enlisted	16,995	356	20.95			5,938	.96
Colored enlisted	4,456	65	14.59			1,025	.63
Total enlisted	21,451	421	19.63			6,963	.89
U. S. Army in Hawaii:							
White enlisted	16,161	228	14.11	1	.06	4,482	.76
Colored	3,319	107	32.24			1,623	1.34
Total	19,480	335	17.20	1	.05	6,105	.86
U. S. Army in Panama: White enlisted	19,688	82	4.17			1,324	.18
U. S. Army in other countries not stated:							
White enlisted	(a)	1,850				32,239	
Colored enlisted	(a)	107				2,220	
Color not stated		107				2,004	
Total	14,232	2,064	145.06			36,463	7.02
Transports:							
White enlisted	97,498	2,380	24.41	1	.01	35,791	1.01
Colored enlisted	10,535	835	79.26			9,377	2.44
Color not stated		28		1		198	
Total	108,033	3,243	30.02	2	.02	45,366	1.15
Native troops enlisted:							
Philippine Scouts	18,576	504	27.13			7,330	1.08
Hawaiians	5,615	43	7.66			465	.23
Porto Ricians	11,831	129	10.90			1,630	.38

[a] Separate strength of white and colored not available.

Mumps caused more noneffectiveness among colored troops than among white troops; there were 3,020,897 days lost from duty among 3,599,527 white enlisted men and 656,383 days lost among 286,548 colored enlisted men. These figures give a ratio of 2.30 for white enlisted men and 6.28 for colored per 1,000 strength. Thus the noneffectiveness was approximately three times greater among colored troops than among white. Mumps was widely distributed over the United States and was reported from all stations, as is shown in Table 74. The camps that had the largest occurrence among white enlisted men, were, in the order named: Camp Beauregard, La.; Camp Wheeler, Ga.; Camp Bowie, Tex.; and Camp Travis, Tex. The admission ratios per 1,000 strength for the camps mentioned were all above 213 per 1,000 strength. The camps reporting the smallest number of total cases were Camp Syracuse, N. Y.: Camp Forrest, Ga.; and Camp Cody, N. Mex. The first two camps were small, with a mean strength of about 10,000 troops. Camp Cody, N. Mex., though a camp of average size, reported only 333 cases, giving a ratio of 14.71 per 1,000 strength. The average number of cases per camp in the United States was 2,650 and the average ratio per 1,000 strength was 81.40. It is seen that

of the 39 camps shown in Table 74, 16 reported cases above the average in number and 13 had a primary admission ratio above the average among total troops.

TABLE 74.—*Mumps. Admissions, by camps of occurrence, white and colored enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers*

Camps	Average strength for period	Primary admissions					
		White enlisted men		Colored enlisted men		Total	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
Camp Beauregard, La	20,625	4,725	233.88	81	191.94	4,806	233.01
Camp Bowie, Tex	26,193	5,387	213.43	104	109.13	5,491	209.63
Camp Cody, N. Mex	22,636	333	14.71			333	14.71
Camp Custer, Mich	37,631	1,676	46.20	141	103.98	1,817	48.28
Camp Devens, Mass	47,921	722	15.80	557	250.90	1,279	26.68
Camp Dix, N. J	49,786	849	18.88	408	84.74	1,257	25.24
Camp Dodge, Iowa	39,032	2,616	78.73	1,476	254.22	4,092	104.83
Camp Doniphan, Okla	26,747	1,377	51.48			1,377	51.48
Camp Eustis, Va	6,780	306	48.39	83	182.02	389	57.37
Camp Forrest, Ga	8,980	40	4.45			40	4.45
Camp Fremont, Calif	15,414	455	29.52			455	29.52
Camp Funston, Kans	56,222	5,874	117.35	1,092	177.05	6,966	123.90
Camp Gordon, Ga	44,871	2,752	72.33	2,364	346.50	5,116	114.01
Camp Grant, Ill	49,256	1,390	32.85	1,163	167.61	2,553	51.83
Camp Greene, N. C	29,710	2,423	92.55	387	109.66	2,810	94.58
Camp Greenleaf, Ga	11,959	243	20.32			243	20.32
Camp Hancock, Ga	37,994	849	23.32	238	149.22	1,087	28.61
Camp Humphreys, Va	12,836	344	35.27	613	198.78	957	74.55
Camp Jackson, S. C	42,011	4,183	113.42	1,102	214.86	5,285	125.80
Camp Johnston, Fla	22,267	1,162	58.52	412	170.82	1,574	70.68
Camp Kearny, Calif	25,472	1,752	68.78			1,752	68.78
Camp Lee, Va	57,635	3,388	66.43	875	131.96	4,263	73.96
Camp Lewis, Wash	47,792	4,676	98.93	26	49.53	4,702	98.38
Camp Logan, Tex	27,734	416	15.60	90	84.19	506	18.24
Camp MacArthur, Tex	25,271	1,076	44.25	25	26.23	1,101	43.56
Camp McClellan, Ala	28,664	723	27.25	276	129.58	999	34.85
Camp Meade, Md	50,033	672	16.01	503	62.50	1,175	23.48
Camp Mills, N. Y	24,197	1,079	47.04	214	170.26	1,293	53.43
Camp Pike, Ark	49,587	5,848	143.09	1,456	167.02	7,304	147.29
Camp Sevier, S. C	27,786	5,245	200.34	125	77.84	5,370	193.26
Camp Shelby, Miss	30,432	2,637	91.63	378	228.81	3,015	99.07
Camp Sheridan, Ala	26,507	977	38.13	43	48.59	1,020	38.48
Camp Sherman, Ohio	42,750	2,224	60.17	912	157.65	3,136	73.35
Camp Syracuse, N. Y	3,367	4	1.19			4	1.19
Camp Taylor, Ky	46,962	2,880	67.64	338	77.06	3,218	68.52
Camp Travis, Tex	44,264	7,998	213.22	1,073	163.24	9,071	204.92
Camp Upton, L. I., N. Y	44,871	608	15.12	1,009	216.11	1,617	36.03
Camp Wadsworth, S. C	31,809	415	13.77	88	52.60	503	15.81
Camp Wheeler, Ga	25,726	5,144	215.13	248	136.64	5,392	209.59
Others	339			10	29.50	10	29.50
Total	1,270,069	85,468	73.71	17,910	161.93	103,378	81.40

OCCURRENCE IN THE UNITED STATES

The seasonal occurrence of disease is well shown by mumps in the Army in the United States during the World War. The average admission ratio for mumps in the United States was 66.30 per 1,000 per annum. (Table 75.) In October, 1917, the admission ratios for white troops increased, reaching the maximum in February of the year following. Reviewing the occurrence among white troops only, we find that in October, 1917, 1,683 cases were reported as primary admissions. The ratio was 19.57 per 1,000 strength. In November of this year, 4,179 cases were reported as primary admissions, giving a ratio of 47.25 per 1,000 per annum. The following month, December, both the number of cases and the ratio were more than doubled. There were 10,368 primary admissions, giving a ratio of 110.19 per 1,000 strength. In January, 1918, again these numbers were practically doubled. There were 19,460 primary admissions and the ratio per 1,000 strength was 212.98. In February, 1918, although there was an increase, this increase was not in the same proportion as had occured during the several preceding months. There were 21,092 primary

admissions, with a ratio of 231.14 per 1,000 strength. From this date the number of cases and the ratio decreased until the second seasonal occurrence, which occurred in the following November. The seasonal occurrence commencing in 1918 did not reach the same magnitude in the United States as did the seasonal occurrence which started in 1917. The seasonal occurrence of 1918 began one month later, with 2,729 primary admissions, giving an admission ratio of 26.09 per 1,000 strength. In December, twice as many cases were reported with more than double the admission ratio—that is, 4,718 primary admissions and a ratio of 60.16 per 1,000 per annum. Although there was an increase in January, 1919, it was not in the same geometrical proportion as had occurred in the previous year. For this month, 6,027 primary admissions were reported with a ratio of 107.48 per 1,000 strength. In February, 1919, the occurrence of mumps began to decrease, and continued to decrease to the end of the war. There was no seasonal occurrence in the latter part of 1919.

TABLE 75.—*Mumps. Admissions, by months, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919*

Year and month	White enlisted men									
	United States					Europe				
		Admissions		Deaths			Admissions		Deaths	
	Mean strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Mean strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
1917										
April	183,758	485	31.67							
May	245,454	634	30.99							
June	309,205	771	29.92			[a]13,420	[a] 9	8.05		
July	458,817	754	19.72			28,821	256	106.58		
August	562,714	578	12.33			50,882	335	79.01		
September	776,466	731	11.30			70,266	288	49.18		
October	1,032,244	1,683	19.57			92,139	258	33.60		
November	1,061,422	4,179	47.25	1	.01	123,429	708	68.83		
December	1,129,065	10,368	110.19	13	.14	160,178	1,478	110.73	1	.07
Total 1917	479,929	20,183	42.05	14	.03	44,928	3,332	74.16	1	.02
1918										
January	1,096,434	19,460	212.98	17	.19	193,264	2,693	167.22	1	.06
February	1,095,039	21,092	231.14	12	.13	223,130	3,087	166.02	2	.11
March	1,129,223	13,950	148.24	11	.12	283,268	3,234	137.00		
April	1,168,558	7,181	73.74	4	.04	388,048	1,626	50.28	1	.03
May	1,197,757	4,136	41.44	1	.01	587,240	1,579	32.27	1	.02
June	1,303,746	2,366	21.78			796,427	1,293	19.48	2	.03
July	1,328,513	2,211	19.97	1	.01	1,063,192	1,264	14.27	1	.01
August	1,284,247	1,883	17.60			1,266,592	1,587	15.04	3	.03
September	1,321,440	1,872	17.00	6	.05	1,527,793	3,018	23.70	8	.06
October	1,343,933	1,817	16.23	5	.04	1,635,321	4,347	31.90	10	.07
November	1,255,195	2,729	26.09	2	.02	1,682,836	6,477	46.19	3	.02
December	941,219	4,718	60.16	11	.14	1,591,962	8,864	66.82	5	.04
Total 1918	1,205,442	83,415	69.20	70	.06	936,589	39,069	41.71	37	.04
1919										
January	672,937	6,027	107.48	4	.07	1,488,683	6,399	51.58	3	.02
February	471,815	3,972	101.02			1,310,083	3,835	35.13	1	.01
March	406,839	2,254	66.48	1	.03	1,115,693	2,648	28.48	1	.01
April	339,836	843	29.77			853,425	1,220	17.15		
May	291,810	344	14.15			569,842	539	11.35		
June	246,903	172	8.36			271,633	198	8.75		
July	215,104	56	3.12			111,634	153	16.45		
August	156,791	56	4.29			48,006	94	23.49		
September	149,360	62	4.98			30,315	24	9.50		
October	139,877	31	2.66			21,055	3	1.71		
November	132,403	24	2.18			18,920	1	.63		
December	135,441	52	4.61			18,379	2	1.31		
Total 1919	279,926	13,893	49.63	5	.02	488,139	15,116	30.97	5	.01
Month not stated		7					37			
Total for period	1,965,297	117,498	59.78	89	.05	1,469,656	57,554	39.16	43	.03

[a] Includes April and May.

TABLE 75.—*Mumps. Admission, by months, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919*—Continued

Year and month	Colored enlisted men									
	United States					Europe				
	Mean strength	Admissions		Deaths		Mean strength	Admissions		Deaths	
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
1917										
April	4,870	10	24.63	1	2.46					
May	5,826	4	8.23							
June	5,171	4	9.28							
July	6,675	11	19.78							
August	8,519	5	7.04							
September	9,409	14	17.86							
October	21,795	29	15.97			935	1	12.82		
November	39,225	82	25.09			2,392	57	286.43		
December	36,851	330	107.46			5,346	357	800.45	1	2.24
Total 1917	11,529	489	42.41	1	.09	723	415	574.00	1	1.38
1918										
January	50,705	1,870	422.60	3	.71	8,673	1,235	1,708.16	1	1.38
February	49,955	2,406	577.95	1	.24	9,664	923	1,146.58		
March	54,814	1,351	295.75	5	1.09	11,541	149	154.89		
April	59,015	1,257	255.60	1	.20	12,667	287	271.78		
May	87,650	2,060	282.04	3	.41	28,279	593	251.59		
June	89,305	1,859	249.80	2	.27	33,208	622	224.79	1	.36
July	124,976	1,047	100.53	1	.10	47,171	942	239.63	2	.51
August	168,422	931	66.33	2	.14	78,734	1,053	160.49	2	.31
September	164,846	1,080	78.62	3	.22	91,270	1,195	157.11	4	.53
October	182,706	1,486	97.60	1	.07	138,827	1,892	163.54	3	.26
November	150,587	2,094	166.87	1	.08	148,679	2,972	239.87	2	.16
December	104,140	2,094	241.30	1	.12	148,372	1,429	115.58	1	.08
Total 1918	107,260	19,535	182.13	24	.22	63,090	13,292	210.68	16	.25
1919										
January	68,337	1,357	238.32			140,396	546	46.67	1	.09
February	66,104	766	139.05	2	.36	131,219	271	24.78	1	.09
March	44,634	194	52.15			123,152	232	22.61		
April	29,824	93	37.42			119,801	120	12.02		
May	20,780	20	11.55			108,650	112	12.37		
June	18,562	16	10.34			64,166	32	5.98		
July	20,058	8	4.79			12,508	1	.96		
August	18,013					1,741				
September	11,322	1	1.06			1,287				
October	9,084					185				
November	8,792	2	2.73			83				
December	8,935	1	1.34							
Total	27,037	2,458	90.91	2	.07	58,599	1,314	22.42	2	.03
Month not stated							2			
Total for period	145,826	22,482	154.15	27	.19	122,412	15,023	122.72	19	.16

The above review of occurrence for white enlisted men in the United States applies, in general, to the occurrence of mumps among the colored enlisted men. Mumps was more common among colored enlisted men, but the ratios during the latter part of 1917 were lower than those for white enlisted men in the respective months; however, the number of colored troops in the Army at that time was small. By January, 1918, the number of colored troops had greatly increased. The mean aggregate strength for 1917 was 11,529; during 1918, the mean aggregate strength was 107,260. Commencing in January, 1918, the occurrence of mumps among colored enlisted men was greater than among white enlisted men. This occurrence continued until the spring of 1919. The highest ratio for colored enlisted men was in February, 1918, which was 577.95 per 1,000 per annum. From this date there was a decrease in the admission ratio until

the following October. As in the case of white enlisted men, the second seasonal occurrence, which commenced in October, 1918, although greater among white enlisted men, did not reach the magnitude of the preceding year. The largest number of cases of mumps reported among colored enlisted men for any one month was in February, 1918. There were 2,406 primary admissions in the United States for that month.

From all points of view mumps was more important among colored than among white troops. As has been stated above, the admission, discharge, and noneffective ratios were higher among the former. The explanation is believed to lie in the fact that a larger proportion of colored troops was drafted from rural districts.

It has been shown that the occurrence of mumps in the Army in the United States was a matter of serious concern during mobilization. No men were enlisted in the Army during the first two months of 1919 and comparatively few during the early spring. The admission rate, as shown by Table 75, was on the decline at this time, and much below that of the corresponding months of the preceding year. Large numbers of troops were returned to the United States from Europe during the latter months of 1918, and throughout the remaining portion of the winter and spring of 1919. In spite of the fact that large numbers of troops were sent into the larger camps of the United States from January, 1919, to June of that year, the admission ratio for mumps decreased. Therefore, one may say that demobilization had no influence on increasing the the ratio of mumps in the camps.

OCCURRENCE IN THE AMERICAN EXPEDITIONARY FORCES

Table 73 shows the part played by mumps in the Army in Europe during the World War. There was a total of 81,853 primary admissions, with an average annual ratio of 49.14 per 1,000 strength. The highest admission ratio was for colored enlisted men—122.72 per 1,000 strength. As in the United States, colored enlisted men in the American Expeditionary Forces had an admission ratio far greater than did white enlisted men.

The great importance of mumps in the Army overseas, as in the United States, was due to the amount of time lost from duty. Table 73 shows 1,501,222 days lost from this disease in the Army in Europe, giving a noneffective ratio of 2.47 per 1,000 per annum. Again the ratio was greater for colored enlisted men. White enlisted men had a noneffective ratio of 1.98 and colored enlisted men 5.98 per 1,000 per annum.

FACTORS INFLUENCING OCCURRENCE

Many factors enter into the occurrence of mumps. According to Zinsser[1] "Our impression from Army experience is that there may be carriers." Radin[2] found that 95 per cent of the cases at Camp Wheeler, Ga., occurred during the first two months of service. A physical condition below par was found to be a factor of some predisposing importance, and most of the cases were from rural districts. As mentioned above, mumps had distinct seasonal occurrences. From October to March, in temperate climates, mumps occurred most frequently. Racial influences were marked during the war, and there was a great

difference in the occurrence of this disease between white and colored troops, being more common among the latter. It is also probable that crowding had a marked influence on the occurrence of mumps; however, there is no record of any experiments conducted along these lines during the World War period.

One attack of mumps usually confers immunity, but not necessarily so.

SYMPTOMS

The usual onset of mumps was characterized by pain, swelling, and stiffness about the angle of the jaw, made more noticeable by opening the mouth. There was usually malaise and some fever. Like many other diseases where the bacteriology is not known, diagnosis was often very difficult. The leucocyte count was usually normal in the uncomplicated case; sometimes there was leucopenia. When complications occurred, especially orchitis, there was usually a mild leucocytosis. Radin [2] summarized the onset of mumps as follows: Onset with no symptoms; onset with gastric disturbances and features suggesting pancreatitis; onset with pancreatitis, orchitis, and urethral discharges; onset with features of acute laryngitis and bronchitis; griplike onset, with fever, headache, malaise, sore throat, and pain in the bones; onset with inguinal pain and backache; and the ordinary onset. The same observer summarized the physical signs of mumps as (1) Hatchcock's sign; (2) pouting and pinkness of the orifices of Steno's duct; (3) swelling of the face in the parotid region; (4) doughy elasticity of the swelling; (5) discharge of secretion from Steno's duct on pressure over the gland externally. This author describes Hatchcock's sign as follows:[2] "The sign is tenderness just beyond the angle of the jaw on running the finger toward the angle, under the mandible. If the parotid gland is at all involved, the patient winces with pain. This occurs before any swelling can be made out."

Pouting of the orifice of Steno's duct, with a pink areola on the mucous membrane around the mouth of this duct, has often been described as occurring in mumps. It was reported as occurring only on the side where mumps was present. On inserting a cannula into the mouth of Steno's duct, a fluid will often be ejected if mumps is present. According to Radin, elevation of temperature was not constant, occurring in about 80 per cent of the cases; the range of temperature was most commonly from 99° to 101° F., and duration was from 1 to 24 days, with an average of 4 days. About 24 hours before the onset of a complication, a rise in temperature of from 1° to 3° was noticed. This was usually accompanied by leucocytosis, the polymorphonuclear leucocytes showing a relatively higher percentage in the orchitic than in the uncomplicated cases. In the latter the average was 51.9 per cent; in the orchitic cases the percentage was 60.2. These findings were reversed in the case of lymphocytes; the relative percentage of lymphocytes was 38.4 in uncomplicated and 34.5 in orchitic cases. Vomiting, nausea, and orchitic pain may occur without apparent cause.

The period of incubation is from two to three weeks.[3] Radin [2] had occasion to report upon this subject in the case of two nurses who were not immune to mumps and placed on duty in a mumps ward. One nurse developed mumps in two weeks and the other in two and a half weeks after exposure.

Although mumps may involve the submaxillary, sublingual, and occasionally the lachrymal glands, as well as the parotid glands, the system of recording diagnoses in the Surgeon General's Office does not permit such detailed analysis of cases.

The average duration per case was 16.86 days for the total Army. The average number of days in hospital for mumps in the United States was 16.07 days and in Europe 18.34 days.

PATHOLOGY

But little is known of the pathology of mumps. Although typical mumps involves the parotid glands only, the other salivary glands may be involved. Osler [3] is the authority for the statement that the submaxillary and sublingual glands may become swollen, though not always; in a few cases they alone may be attacked. Radin [2] reported that a parotid gland was removed by mistake in a case of mumps at Camp Wheeler. After its removal, advantage was taken of the opportunity to observe the structure of the gland. This proved to be normal. Cervical and inguinal adenitis were not infrequent. Orchitis was frequent and redness of the scrotum and epididymitis often occurred. The thymus gland was enlarged in some of Radin's cases. Involvement of the pancreas is supposed to occur in mumps at times, but the exact pathology has not been reported. In mumps meningitis, according to Larkin,[4] the meninges showed lymphatic and edematous changes associated with some encephalitis. The spinal fluid was clear in these cases and showed an increased cell count (lymphocytes). The fluid was sterile on bacteriological examination. Larkin reported two cases of mumps meningitis, one with a cell count of about 20 per c. mm. and the other of about 200. Leucocytosis was present in the blood in both cases. The autopsy findings in one of Larkin's cases were as follows:[4]

* * * * * * *

Autopsy.—At autopsy an early bronchopneumonia, acute diffuse splenitis, and acute parenchymatous nephritis were found. On removing the brain an extensive accumulation of slightly turbid fluid in the cisterna magna was observed. The pia-arachnoid was congested. In many places a perivascular exudate was seen in the form of grayish-yellow lines following the course of the blood vessels. The ventricles were somewhat distended. The fluid was clear. The ependyma was slightly granular. Cultures (aerobic) from the perivascular exudate and from the spinal fluid were negative. Microscopic sections showed the pia-arachnoid densely infiltrated with large and small mononuclear cells. The infiltration was definitely perivascular, but also extended into the areolar tissue and cortex. Similar cells were adherent to the arterial intima.

* * * * * * *

DIAGNOSIS

The ordinary case of mumps is not difficult to diagnose correctly, especially in the presence of an epidemic. There may be cases, however, of a mild type, or cases involving salivary glands other than the parotid gland, where the diagnosis is difficult. The difficulty is increased by the absence of any positive laboratory findings characteristic of mumps. The following clinical signs and symptoms, when present, are pathognomonic: Swelling and tenderness of the salivary gland unilateral or bilaterial; pink and pouting orifice of Steno's duct, discharge of a whitish secretion from the duct upon pressure on the gland

involved, or by aspiration; pain or a drawing sensation in the mouth on eating sour food; Hathcock's sign. These findings are usually accompanied by some elevation of temperature and an absence of leucocytosis. A sudden rise of temperature during the course of mumps leads one to suspect complications. These complications are usually accompanied by leucocytosis. Orchitis, with swelling and some tenderness, is the most common complication. It may be bilateral or unilateral, is often accompanied by epididymitis, and may be followed by atrophy. Pain in the ear on the side involved by mumps is not uncommon, and may be due to the swollen parotid gland or to otitis media. Headache, stiffness of the neck muscles, positive Kernig's sign, with sudden increase in temperature and the number of leucocytes, should lead one to suspect meningitis. Confirmation of the diagnosis is made by lumbar puncture. The spinal fluid in mumps meningitis is clear on withdrawal, has an increased cell count, and the fluid is sterile. A fine whitish sediment forms on standing. It is important to differentiate this form of meningitis from other forms, especially the epidemic variety. Larkin gives the following differential diagnostic table:[4]

	Mumps	Tuberculosis	Influenza
Appearance on withdrawal	Usually clear	Usually clear	Cloudy.
Appearance after 14 hours	Fine white sediment	"Spider web" or "Velum"	Yellowish-white sediment.
Cell count	200	200	500.
Type	Lymphocytes	Lymphocytes	Leucocytes.
Bacteriology	Sterile	B. tuberculosis	B. influenzæ.

	Pneumonia	Streptococcus infection	Epidemic meningitis
Appearance on withdrawal	Turbid	Turbid	Turbid.
Appearance after 14 hours	Heavy purulent	Very purulent	Heavy purulent sediment.
Cell count	500	500	500.
Type	Leucocytes	Leucocytes	Leucocytes.
Bacteriology	Pneumococcus	Streptococcus	Meningococcus.

In submaxillary mumps, differential diagnosis from tonsillitis with cervical adenitis is necessary. In this form there is usually an epidemic of mumps present and the tonsils are normal; the swelling is under the center of the mandible and the salivary gland is involved. On the other hand, the confusing cervical adenitis is of inflammatory origin, not epidemic, and involves the lymphatic gland which is located somewhat farther back than is the salivary gland.

TREATMENT

Experience during the war developed no specific treatment for mumps, and none is known. It was the practice in the Army to isolate all cases and to retain them in quarantine until they were no longer a source of danger. Some hospitals adopted the plan of a 21-day quarantine; others based the quarantine on clinical findings of the individual case—when there was no longer swelling of the salivary glands and no complications were present, the cases were assumed to be free of infection. The presence of a temperature above normal was a counterindication for discharge from hospital; however, a normal temperature did not mean that the patient was not a source of danger.

Cubicled beds and gauze masks were utilized as preventives of spread of the disease in hospitals, in some instances both the patients and the attendants

being masked. There is no record of proof, however, that either of these methods was of great value in preventing the spread of mumps. There was a difference of opinion as to the value of this practice. In some instances uncomplicated mumps patients were allowed up and walked to their meals, while others were treated strictly as bed patients. A review of the available literature does not show any great difference in the percentage of complications, especially orchitis, that developed with these two different forms of treatment. Some patients were allowed to get up for meals and to walk about generally, while others were required to remain in bed throughout the course of the disease.[2]

The ordinary uncomplicated case of mumps required no medication. When medicaments were administered, these varied in different camps. Radin[2] reported that orchitis occurred one-third less frequently in patients treated with hexamethylenamin than in those patients who did not receive this form of medication. Orchitis was reported as being less common at Camp Grant where bromides were used.[5] Particularly was this true among colored patients. Local applications of heat or cold were used, according to the preference of the patient. Radin used Dobell's gargle, hot applications, and camphorated oil over the swollen salivary glands, and aspirin and bromides internally for pain and nervousness. The early stage of otitis media was most commonly treated by instilling 2 drops of a 2 per cent phenolized glycerin into the external auditory canal, and sometimes into each nostril, twice daily. Where an exudate was present, manifested by bulging of the tympanum, early incision and drainage was the procedure of election. Orchitis was treated by support, and counterirritation in the form of ice bags, ichthyol, or guaicaol carbonate. Rest in bed was the best form of treatment. Mumps meningitis was treated by spinal drainage.

COMPLICATIONS AND SEQUELÆ

Of the 230,356 cases of mumps reported as primary admissions, 40,008 developed complications of some kind. In addition to the above, there were 6,107 cases reported during the World War as concurrent with other diseases. The case mortality among the primary admissions was 0.08 per cent and the case mortality among cases of mumps reported as a concurrent disease was 2.11 per cent. The most common complication in mumps was orchitis. There were 24,337 cases of mumps admitted as primary admissions which developed complications of the genitourinary system, other than venereal; that is, 10.56 per cent. It is presumable that the vast majority of these cases were orchitis, epididymitis, or both. Radin[2] reported this complication in 13.91 per cent of the cases at Camp Wheeler, Ga. Orchitis, bilateral, occurred in 102 cases, and unilateral orchitis in 452 cases. Epididymitis alone was reported by Radin in 5 cases. At Camp Shelby Miss., orchitis was reported as a rather frequent complication, and principally among the colored labor battalions. Fort Riley, Kans., reported orchitis present in from 20 per cent to 25 per cent of the cases of mumps in 1917 and in about 5 per cent in 1918. Camp Lewis, Wash., reported epididymitis in 7 per cent, orchitis in 21 per cent, and epididymitis and orchitis in 4 per cent of their cases. Orchitis was a frequent and an annoying complication of mumps in the American Expeditionary Forces. Among the

4,500 cases reported by Camp Hospital No. 52, A. E. F., orchitis was the only complication of special note.

Next to orchitis, meningitis may be taken as the most important complication occurring in mumps. Haden [6] reported 9 cases of mumps with cerebral complications, at Camp Lee, Va., among 476 cases of mumps. This complication usually occurred late in the disease. In the careful study of more than 5,000 cases of mumps by Radin,[2] no mention was made of meningitis. Larkin [4] reported 2 cases of mumps meningitis at Camp Taylor, Ky., during the World War, 1 of which died. The autopsy findings in the case which died have been quoted previously in this chapter. Several cases of mumps with signs of meningeal irritation manifested by headache, irritability, restlessness, slight cervical rigidity, suggested Kernig's sign, high temperature, and respiration, were reported at Camp Lewis, Wash. These signs disappeared in from 24 to 48 hours. In 1917, 2 cases of mumps meningitis among 1,800 cases of mumps were reported at Beauregard, La. One case of mumps meningitis was reported from Base Hospital No. 106, A. E. F. in 1917.

Acute pancreatitis in mumps was reported during the war. The monthly sick and wounded reports of the Surgeon General's Office show 26 such cases. Radin [2] reported 14 cases at Camp Wheeler, Ga., or 0.31 per cent of the cases. This complication was reported from Camp Lewis, Wash., in 0.2 per cent of the cases.

Among the total primary admissions of 230,356 cases, otitis media was reported in 906, lobar pneumonia in 701, bronchopneumonia in 320, arthritis in 184, acute articular rheumatism in 231, measles in 436, scarlet fever in 288, bronchitis in 1,223, and diphtheria carriers in 208 cases. The records would indicate that the death rate of the concurrent disease was not increased by the coexistence of mumps.

The report of Radin [2] permits analysis of the involvement of the various salivary glands in a large number of mumps cases studied by him. Both parotids alone were involved in 2,747 of his 5,756 cases, that is, 47.7 per cent; the right or left parotid alone was involved in 20.5 per cent; both submaxillary glands alone were involved in 16, or 0.27 per cent, of the cases, and the submaxillary salivary gland on one side alone was involved in 18 cases, or 0.31 per cent. The sublingual salivary glands were involved in 31 cases, either conjointly with other salivary glands or alone. The parotid glands were involved in 73.71 per cent, the submaxillary glands in 7.64 per cent, and the sublingual glands in 5.21 per cent.

One case of suppuration of the parotid gland was reported by Radin,[2] but there was a question as to whether the gland proper was involved in the suppurative process or whether the process was one of suppurative cellulitis. One case of parotid abscess was reported from Camp Pike, Ark., in October, 1918, following mumps. This case died.

PREVENTIVE MEASURES

From a military point of view, the control of mumps is a very important problem; however, no satisfactory method has yet been devised for controlling this disease. The length of time that a patient may be a source of infection is

not known. It is not known when the communicable stage starts, or when it definitely ends; therefore quarantine was not required during the war, except in isolating patients. Contact cases were not quarantined. On account of the high degree of contagiousness of this disease, it spread rapidly through the various commands soon after mobilization. At Camp Wheeler, Ga., Radin [2] reports that 32 per cent of the command developed this disease. The general preventive measures used there were removal of patients from their companies as soon as the disease appeared, retaining them in quarantine at the hospital until they appeared no longer a source of contagion. No measures used appeared to control, or even check, the spread. Since the virus has been reported to be contained in the saliva, boiling of all mess equipment, such as knives, forks, spoons, cups, plates, etc., would appear to be of great value, thus preventing the spread of mumps through this medium. It was customary to boil mess equipment during the World War, but there is no report upon its efficacy in controlling the spread of mumps.

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CHAPTER XIV

GERMAN MEASLES [a]

STATISTICAL CONSIDERATIONS

German measles was not of particular importance to the Army during the World War and did not rank among the 30 most common diseases. There were 17,378 primary admissions for the total Army of more than four million officers and men, giving a ratio of 4.21 per 1,000 strength. (Table 76.) There were 524 primary admissions for officers and 17,039 for American officers and enlisted men. The admission ratios were, respectively, 2.54 and 4.16 per 1,000 per annum. There were 16,192 primary admissions for white American troops and 259 for colored American troops, giving admission ratios of 4.50 and 0.90 per 1,000 strength, respectively. There were 64 primary admissions where the clinical records did not specify color.

TABLE 76.—*German measles. Admissions, deaths, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

	Total mean annual strength	Admissions		Deaths		Discharges for disability		Days lost (absolute numbers)	Noneffective (ratio per 1,000 strength)
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength		
Total officers and enlisted men including native troops	4,128,479	17,378	4.21	82	0.02	1	0	211,645	0.14
Total officers and enlisted American troops	4,092,457	17,039	4.16	82	.02	1	0	209,413	.14
Total officers	206,382	524	2.54	----	----	----	----	4,842	.06
Total American troops:									
White	3,599,527	16,192	4.50	77	.02	----	----	198,684	.15
Colored	286,548	259	.90	4	.01	1	0	4,930	.05
Color not stated	----	64	----	1	----	----	----	957	----
Total	3,886,075	16,515	4.25	82	.02	1	0	204,571	.14
Total native troops (enlisted)	36,022	339	9.41	----	----	----	----	2,232	.17
Total Army in the United States, including Alaska:									
Officers	124,266	475	3.82	----	----	----	----	4,336	.10
White enlisted	1,965,297	15,449	7.86	74	.04	----	----	188,378	.26
Colored enlisted	145,826	243	1.67	4	.03	1	.01	4,616	.09
Total enlisted	2,111,123	15,692	7.43	78	.04	1	0	192,994	.25
Total officers and men	2,235,389	16,167	7.23	78	.03	1	0	197,330	.24
U. S. Army in Europe, excluding Russia:									
Officers	73,728	31	.42	----	----	----	----	380	.01
White enlisted	1,469,656	473	.32	3	.00	----	----	6,998	.01
Colored enlisted	122,412	12	.10	----	----	----	----	197	0
Color not stated	----	63	----	1	----	----	----	930	----
Total enlisted	1,592,068	548	.34	4	.00	----	----	8,125	.01
Total officers and men	1,665,796	579	.35	4	.00	----	----	8,505	.01
Officers (other countries)	8,388	18	2.15	----	----	----	----	126	.04

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

TABLE 76.—*German measles. Admissions, deaths, discharges for disability, and days lost, by countries of occurrence, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*—Continued

	Total mean annual strength	Admissions		Deaths		Discharges for disability		Days lost (absolute numbers)	Noneffective (ratio per 1,000 strength)
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength		
U. S. Army in Philippine Islands:									
White enlisted	16,995	16	.94					125	.02
Colored enlisted	4,456								
Total enlisted	21,451	16	.75					125	.02
U. S. Army in Hawaii:									
White enlisted	16,161	46	2.85					1,119	.19
Colored enlisted	3,319	1	.30					71	.06
Total enlisted	19,480	47	2.41					1,190	.17
U. S. Army in Panama (white enlisted)	19,688	9	.46					82	.01
U. S. Army in other countries not stated:									
White enlisted	(a)	63						823	
Colored enlisted	(a)	1						31	
Color not stated		1						27	
Total	14,232	65	4.57					881	.17
Transports:									
White enlisted	97,498	136	1.40					1,159	.03
Colored enlisted	10,535	2	.19					15	0
Total	108,033	138	1.28					1,174	.03
Native troops enlisted:									
Philippine Scouts	18,576	58	3.12					700	.10
Hawaiians	5,615	24	4.27					184	.09
Porto Ricans	11,831	257	21.72					1,348	.31

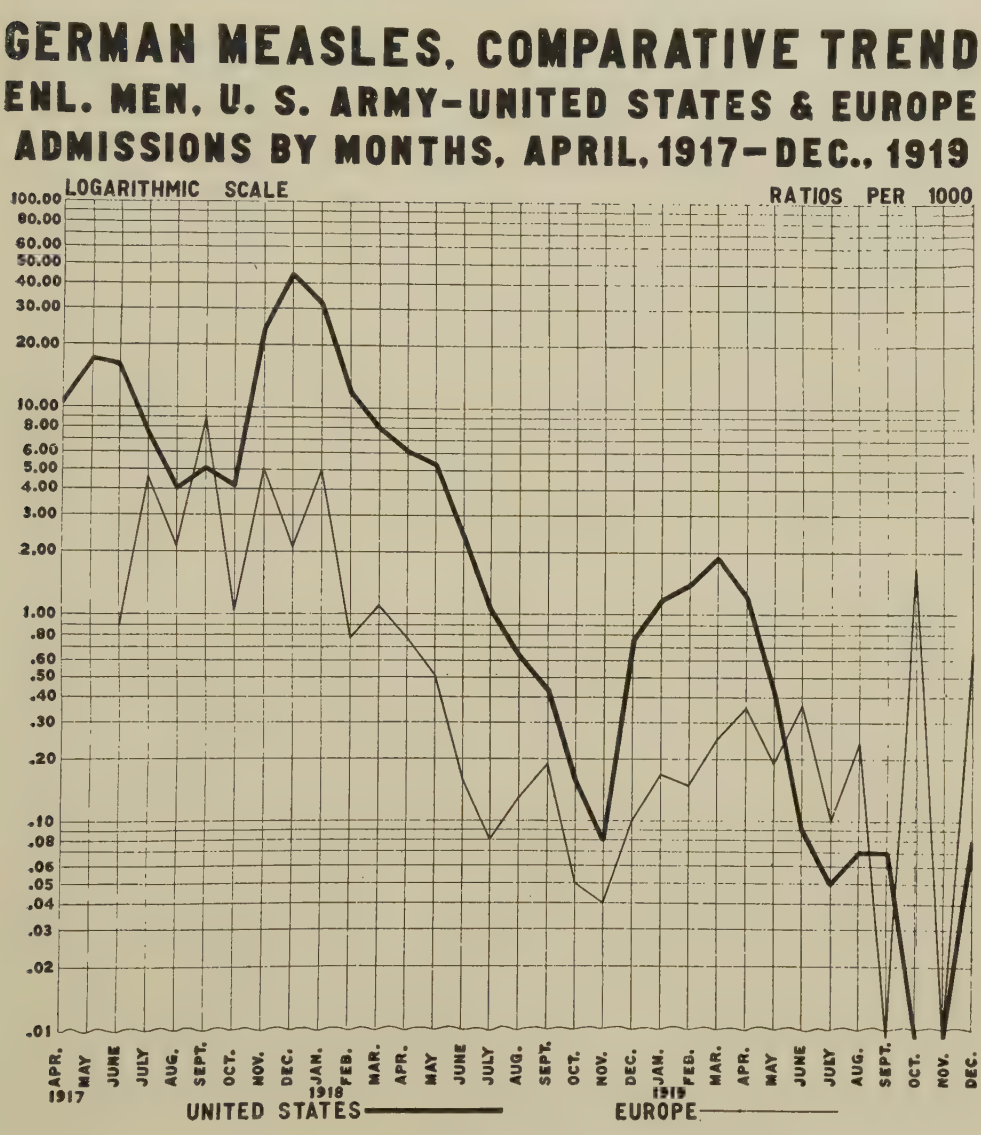
[a] Separate strength of white and colored not available.

It has long been known that German measles is not a fatal disease; therefore all deaths reported for the Army during the World War were, in all probability, due to some concurrent disease. Table 76 shows a total of 82 deaths charged to German measles, 77 of which were among white American troops, 4 among colored American troops, and 1 color not stated. The death ratio was 0.02 per 1,000 strength. One case was discharged from the service on account of disability following this disease. This was a colored American soldier. The permanent disability was due to some other cause.

From the standpoint of noneffectiveness, German measles was a disease of some importance to the Army during the World War. Based on the comparative number of days lost, it stood forty-ninth on the list of common diseases. For the total Army, there were 211,645 days lost from duty, giving a noneffective ratio of 0.14 per 1,000 strength. By far the greater proportion of the time lost was among the white enlisted men. They lost 198,684 days, as compared with 4,930 days lost by colored enlisted men. The noneffective ratios were, respectively, 0.15 and 0.05 per 1,000 per annum. Table 76 shows 4,842 days lost by officers, giving a noneffective ratio slightly higher than that for colored enlisted men. This ratio was 0.06 per 1,000 strength.

The highest admission and noneffective ratios for the total Army were for native enlisted troops. Among a mean strength of 36,022 native troops

(Table 76) there were 339 primary admissions, with a loss of 2,232 days from duty. The admission and noneffective ratios per 1,000 strength were 9.41 and 0.17, respectively. The native troops served in their native countries.



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OCCURRENCE IN THE ARMY IN THE UNITED STATES

Table 76 shows 16,167 primary admissions for the Army stationed in the continental United States. This number represents the vast majority of the cases reported during the war, most of which were among white enlisted men. The admission ratio was 7.23 per 1,000 strength. An analysis of these cases shows 15,449 among white and only 243 among colored enlisted men. The

ratios per 1,000 strength were 7.86 and 1.67, respectively. This disease was more common among officers than among the colored troops; there were 475 primary admissions for the former, a ratio of 3.8 per 1,000 per annum.

According to the system of recording deaths, 74 deaths among white and 4 among colored enlisted men in the United States were charged to German measles. The death ratios were 0.04 and 0.03, respectively. The number reported was so small that, even if they could correctly be attributed to German measles, they would make this a disease of minor importance to the Army during the war.

The importance of this disease to the Army was principally in the number of days lost from duty. Table 76 shows that the officers and men stationed in the United States lost 197,330 days from duty on account of German measles. As would be expected, this was principally among the white enlisted men, since the disease was much more common among them. The noneffective ratio for the total Army in the United States was 0.24 per 1,000 per annum.

The occurrence of German measles by camps in the United States showed wide divergence. (Table 77.) The largest number of primary admissions was reported from Camp Lewis, Wash., where 1,555 cases were reported during the war, the admission ratio per 1,000 strength being 32.54. Camp Cody, N. Mex., was second, with 1,351 primary admissions, the admission ratio, 59.68 per 1,000 strength, being the highest for any camp in the United States. The average admission ratio for all camps in the United States was 7.81.

Though German measles was reported from practically all camps, there were no areas where it could properly be called endemic. Camp Pike, Ark., reported but 11 primary admissions. This is of special interest, since the endemic diseases at Camp Pike, in many instances, were above the average.

Colored troops contributed less than one-fiftieth of the total admissions of 9,915 from the larger camps, there being only 210 primary admissions among them.

TABLE 77.—*German measles. Admissions and deaths, by camps of occurrence, white and colored enlisted men, United States Army, with ratios per 1,000 strength, and case fatality rates, April, 1917, to December, 1919*

Camps	Average strength for period	White enlisted men				Colored enlisted men				White and colored enlisted men				
		Admissions		Deaths		Admissions		Deaths		Admissions		Deaths		Case fatality rates (per cent)
		Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	
Camp Beauregard, La	20,625	18	0.89	0	0	1	2.37	0	0	19	0.92	0		
Camp Bowie, Tex	26,193	31	1.23	1	.04	0	0	0	0	31	1.18	1	0.03	3.23
Camp Cody, N. Mex	22,636	1,351	59.68	6	.27					1,351	59.68	6	.27	.44
Camp Custer, Mich	37,631	180	4.96	1	.03	1	.74	0	0	181	4.81	1	.03	.55
Camp Devens, Mass	47,921	363	7.94	1	.02	12	5.41	0	0	375	7.83	1	.02	.27
Camp Dix, N. J	49,786	322	7.16	0	0	7	1.45	0	0	329	6.61	0	0	
Camp Dodge, Iowa	39,032	100	3.01	1	.03	54	9.30	3	.52	154	3.95	4	.10	2.60
Camp Doniphan, Okla	26,747	208	7.78	4	.15					208	7.78	4	.15	1.92
Camp Eustis, Va	6,780	7	1.11	0	0	0	0	0	0	7	1.03	0	0	
Camp Forrest, Ga	8,980	1	.11	0	0					1	.11	0	0	
Camp Fremont, Calif	15,414	72	4.67	1	.06					72	4.67	1	.06	1.39
Camp Funston, Kans	56,222	515	10.29	0	0	5	.81	0	0	520	9.25	0	0	
Camp Gordon, Ga	44,871	283	7.44	5	.13	31	4.54	0	0	314	7.00	5	.11	1.59
Camp Grant, Ill	49,256	36	.85	0	0	0	0	0	0	36	.73	0	0	
Camp Greene, N. C	29,710	23	.88	0	0	0	0	0	0	23	.77	0	0	
Camp Greenleaf, Ga	11,959	33	2.76	0	0					33	2.76	0	0	
Camp Hancock, Ga	37,994	681	18.71	1	.03	1	.63	0	0	682	17.95	1	.03	.15
Camp Humphreys, Va	12,836	26	2.67	0	0	3	.97	0	0	29	2.26	0	0	
Camp Jackson, S. C	42,011	454	12.31	3	.08	30	5.85	0	0	484	11.52	3	.07	.62
Camp Johnston, Fla	22,267	48	2.42	0	0	1	.41	0	0	49	2.20	0	0	
Camp Kearny, Calif	25,472	456	17.90	0	0					456	17.90	0	0	
Camp Lee, Va	57,635	549	10.76	9	.18	15	2.26	0	0	564	9.79	9	.16	1.60
Camp Lewis, Wash	47,792	1,548	32.75	4	.08	7	13.34	0	0	1,555	32.54	4	.08	.26
Camp Logan, Tex	27,734	217	8.14	2	.08	4	3.74	0	0	221	7.97	2	.07	.90
Camp MacArthur, Tex	25,271	48	1.97	0	0	0	0	0	0	48	1.90	0	0	
Camp McClellan, Ala	28,664	30	1.13	0	0	1	.47	0	0	31	1.08	0	0	
Camp Meade, Md	50,033	447	10.65	0	0	29	3.60	0	0	476	9.51	0	0	
Camp Mills, N. Y	24,197	313	13.64	0	0	2	1.59	0	0	315	13.02	0	0	
Camp Pike, Ark	49,587	11	.27	0	0	0	0	0	0	11	.22	0	0	
Camp Sevier, S. C	27,786	61	2.33	1	.04	0	0	0	0	61	2.20	1	.04	1.64
Camp Shelby, Miss	30,432	36	1.25	0	0	0	0	0	0	36	1.18	0	0	
Camp Sheridan, Ala	26,507	367	14.32	0	0	1	1.13	0	0	368	13.88	0	0	
Camp Sherman, Ohio	42,750	29	.78	0	0	0	0	0	0	29	.68	0	0	
Camp Syracuse, N. Y	3,367	1	.30	0	0					1	.30	0	0	
Camp Taylor, Ky	46,962	307	7.21	5	.12	2	.46	0	0	309	6.58	5	.11	1.62
Camp Travis, Tex	44,264	26	.69	0	0	1	.15	0	0	27	.61	0	0	
Camp Upton, Long Island, N. Y	44,871	174	4.33	1	.02	0	0	0	0	174	3.88	1	.02	.57
Camp Wadsworth, S. C	31,809	309	10.25	1	.03	0	0	0	0	309	9.71	1	.03	.32
Camp Wheeler, Ga	25,726	24	1.00	0	0	0	0	0	0	24	.93	0	0	
Others	339					2	5.90	0	0	2	5.90	0	0	
Total	1,270,069	9,705	8.37	47	.04	210	1.90	3	.03	9,915	7.81	50	.04	.50

When viewed by months and seasons of occurrence, the majority of primary admissions were reported in the United States for November-December, 1917, and January-February, 1918, and among white troops. During these months, there were 2,133, 4,313, 2,980, and 1,139 primary admissions, respectively. During the fall of 1918 and the winter and spring of 1919, German measles was of but little importance to the Army.[1] It is probable that the occurrence during the winter of 1917–18[2] was due to the comparatively large amount of nonimmune material in the Army and to confusion in diagnosis.

TABLE 78.—*German measles. Admissions, by months, white and colored enlisted men, United States Army, United States and Europe. Absolute numbers and ratios per 1,000, April, 1917, to December, 1919*

Month and year	White troops									
	United States					Europe				
		Admissions		Deaths			Admissions		Deaths	
	Mean strengths	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Mean strengths	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength
1917										
April	183,758	164	10.71	1	0.07					
May	245,454	359	17.55			626				
June	309,205	425	16.49			12,794	1	0.89		
July	458,817	289	7.56			28,821	11	4.58		
August	562,714	190	4.05			50,882	9	2.12		
September	776,466	331	5.12			70,266	52	8.88		
October	1,032,244	367	4.27	1	.01	92,139	8	1.04		
November	1,061,422	2,133	24.11	8	.09	123,429	49	4.76		
December	1,129,065	4,313	45.84	24	.26	160,178	29	2.17		
Total 1917	479,929	8,571	17.86	34	.07	44,928	159	3.54		
1918										
January	1,096,434	2,980	32.62	16	.18	193,264	65	4.04		
February	1,095,039	1,139	12.48	6	.07	223,130	11	.59		
March	1,129,223	788	8.37	10	.11	283,268	16	.68		
April	1,168,558	608	6.24	2	.02	388,048	19	.59		
May	1,197,757	500	5.01	2	.02	587,240	24	.49		
June	1,303,746	268	2.47	1	.01	796,427	8	.12		
July	1,328,513	126	1.14	1	.01	1,063,192	4	.05		
August	1,284,247	75	.70	1	.01	1,266,592	13	.12		
September	1,321,440	52	.47			1,527,793	23	.18	2	.02
October	1,343,933	20	.18	1	.01	1,635,321	7	.05		
November	1,255,195	9	.09			1,682,836	6	.04		
December	941,219	65	.83			1,591,962	14	.11		
Total 1918	1,205,442	6,630	5.50	40	.03	936,589	210	.22	2	.002
1919										
January	672,937	67	1.19			1,488,683	22	.18		
February	471,815	62	1.58			1,310,083	16	.15		
March	406,839	66	1.95			1,115,693	23	.25		
April	339,836	36	1.27			853,425	18	.25		
May	291,810	11	.45			569,842	10	.21		
June	246,903	2	.10			271,633	9	.40		
July	215,104	1	.06			111,634	1	.11		
August	156,791	1	.08			48,006	1	.25		
September	149,360	1	.08			30,315				
October	139,877					21,055	3	1.71		
November	132,403					18,920				
December	135,441	1	.09			18,379	1	.65	1	.65
Total 1919	279,926	248	.88			488,139	104	.21	1	.002
Total for period	1,965,297	15,449	7.86	74	.04	1,469,656	473	.32	3	.00

TABLE 78.—*German measles. Admissions, by months, white and colored enlisted men, United States Army, United States and Europe. Absolute numbers and ratios per 1,000, April, 1917, to December, 1919*—Continued

Month and year	Colored troops							
	United States					Europe [a]		
		Admissions		Deaths			Admissions	
	Mean strengths	Absolute numbers	Ratios per 1,000 strength	Absolute numbers	Ratios per 1,000 strength	Mean strengths	Absolute numbers	Ratios per 1,000 strength
1917								
April	4,870	2	4.93					
May	5,826	3	6.17					
June	5,171	1	2.32					
July	6,675							
August	8,519	1	1.41					
September	9,409	1	1.28					
October	21,795					935		
November	39,225	30	9.18			2,392	4	20.10
December	36,851	20	6.51			5,346		
Total 1917	11,529	58	5.03			723	4	5.50
1918								
January	50,705	37	8.76			8,673	2	2.77
February	49,955	13	3.12	1	.24	9,664	1	1.24
March	54,814	4	.88			11,541		
April	59,015	22	4.47	2	.41	12,667	2	1.89
May	87,650	75	10.27	1	.14	28,279		
June	89,305	12	1.61			33,208	1	.36
July	124,976	2	.19			47,171	1	.25
August	168,422	2	.14			78,734		
September	164,846	3	.22			91,270		
October	182,705					138,827		
November	150,587					148,679		
December	104,140	1	.12			148,372		
Total 1918	107,260	171	1.59	4	.04	63,090	7	.11
1919								
January	68,337	6	1.05			140,396		
February	66,104	1	.18			131,219		
March	44,634	5	1.34			123,152	1	.10
April	29,824	2	.81			119,801		
May	20,780					108,650		
June	18,562					64,166		
July	20,058					12,508		
August	18,013					1,741		
September	11,322					1,287		
October	9,084					185		
November	8,792					83		
December	8,935							
Total 1919	27,037	14	52			58,599	1	.02
Total for period	145,826	243	1.67	4	.03	122,412	12	.10

[a] No deaths reported for colored enlisted men in Europe.

The difference between the primary admissions reported from camps, as shown in Table 77, and the total number of primary admissions reported for the United States as a whole is accounted for by troops who had stations other than in the larger camps. Among these were 6,252 primary admissions.

OCCURRENCE IN THE AMERICAN EXPEDITIONARY FORCES

The distribution of German measles among the American Expeditionary Forces was of far less importance, from every point of view, than in the United States. There were 579 primary admissions in the American Expeditionary Forces, with a total mean annual strength of one and a half million men; the admission ratio was 0.35 per 1,000 per annum. White enlisted men contributed most of the cases. There were 473 primary admissions among the white enlisted men, 12 among colored enlisted men, and 63 where color was not stated. Officers contributed 31 primary admissions and had the highest admission ratio for any American troops in Europe. This ratio was 0.42 per 1,000 per annum. The admission ratios for white and colored enlisted men in Europe, respectively, were 0.32 and 0.10 per 1,000 per annum.

From the standpoint of time lost, this disease was of comparatively little importance to the American Expeditionary Forces—there was a total of 8,505 days lost, 6,998 of which were for white enlisted men, 197 days for colored enlisted men.

EPIDEMIOLOGY

Though the exciting cause of German measles is unknown, there is no question as to the identity of this disease or as to its contagious nature. Its infectiousness seems less than that of measles and scarlet fever and to be of but short duration. Table 76 indicates that the negro possesses a relatively high degree of immunity to German measles or that the disease was frequently not accurately diagnosed, since the number of admissions was much greater among white than among colored troops. According to experiences in the United States Army during the World War, the seasonal occurrence of this disease was that of the other exanthematous diseases; in other words, it was most common during the fall, winter, and early spring months. The highest admission ratio, 9.41, was for native enlisted troops. If this is to be taken as an index of immunity, the native troops, particularly the Porto Ricans, are more susceptible to German measles than are even the white American troops.

It is very probable that the infectious agent is contained in the nasopharyngeal discharges of the patient—at least during the catarrhal stage of the disease.

PROGNOSIS

The available records contain no case where death which occurred during the course of an attack of German measles could not be attributed to some other cause.

SYMPTOMS

Patients afflicted with German measles neither appear nor feel very ill. There is a great diversity of opinion as to the duration of the incubation period. Geiger reported the average incubation period among 173 cases studied as 17 days, the shortest being 11, and the longest 21 days.[3] Vaughan gave the wide range of from 5 to 21 days.[4]

Premonitory symptoms are usually present and consist of malaise and mild headache, slight sore throat and, exceptionally, toxic symptoms, such as pain in the joints. Gastrointestinal symptoms are exceptional. There may be elevated temperature with a chilly sensation during this stage, or both may

be absent. The duration of this stage is characteristically short, and the skin rash usually makes its appearance within 24 hours. Some authors state that an enanthem is constantly present and consists of a macular rose-red eruption in the throat. It was on this account that German measles was originally regarded as a hybrid, having the sore throat of scarlet fever and the rash of measles. The mastoid and occipital lymph glands are usually enlarged and painful. Although this adenitis usually occurs late in the disease, it is sometimes one of the earliest symptoms and the physician's attention may be attracted to it by the complaint of tenderness and stiffness of the neck.

The eruption may be the first sign of the disease to attract attention. It appears on the face and, unlike scarlet fever, involves the perioral region. In the beginning it is usually discrete, macular, somewhat punctate, slightly elevated, and disappears easily on pressure. Itching is usually not present.

Geiger reported 15 recurrences in a study of 173 cases.[3] In 5 cases there were three separate attacks. In 2 cases, the second attack occurred three weeks after the first and was followed by a third attack five weeks later.

COMPLICATIONS AND SEQUELÆ

Geiger reported that complications were not infrequent in his cases, nor were they of a mild type.[3] Acute arthritis was noted in 36 of his cases. Recovery was slow. In 4 cases hemolytic streptococcus was obtained in pure culture from the knee joint. In two cases acute nephritis was noted. Endocarditis was a complication in 1 case and otitis media in 8. Neither pneumonia nor jaundice was reported by Geiger.

The statistical records of the Surgeon General's Office for the World War period show 38 cases of German measles reported as concurrent with measles and 32 cases as concurrent with scarlet fever. Conversely, there were 21 cases of measles and 54 cases of scarlet fever recorded as concurrent with German measles, the only difference between these two classes being a question of which disease was reported as the primary cause of admission. There were no deaths among these cases.

DIAGNOSIS

The diagnosis of German measles is based upon the mildness of onset, the mildness of symptoms and signs, the incubation period, special adenopathy, and characteristics of the skin eruption. The differential diagnosis between German measles, measles, and scarlet fever is most important. Measles is differentiated by the following diagnostic points: The incubation period is shorter, and catarrhal symptoms of the respiratory tract are more pronounced. The differential diagnosis between German measles of the scarlatiniform type of rash and scarlet fever is more difficult. The distinctive points in favor of the latter are the shorter incubation period; more severe initial symptoms, as vomiting, sore throat, fever, headache, rapid pulse, "strawberry tongue," greater tendency to complications, and characteristics of the skin eruption.

Toxic and drug rashes at times must be differentiated from the rash of German measles. The former skin rashes are irregularly distributed and they are polymorphous in character. Glandular involvement and catarrhal affections of the respiratory tract are absent in the toxic and drug rashes.

Confusion in diagnosis undoubtedly existed in the early part of the war period, more especially in the fall of 1917. This is believed to account for the occurrence of German measles in epidemic proportions in some camps and its practical absence in others. No other explanation can be offered to account for these differences, since the military conditions were the same. The camp surgeon at Camp Lewis reported that German measles was epidemic in November and December, 1917, with a total of 1,203 cases; however, that figure should be considered advisedly, as there was at that time still some confusion as to the diagnosis. This was the camp that reported the largest number of cases. The difficulty seems to have been principally in differentiating measles, which was epidemic in the camps at that time. Table 79, prepared from a selected group of camps, shows that, generally speaking, where the admission rate for measles was above the average for camps in the United States the rate for German measles was lower than the average; and, vice versa, where the rate for German measles was high the rate for measles was below the average. This table shows a close similarity in the trend of scarlet fever with that of German measles when compared as above outlined and would indicate confusion in the diagnosis of these three diseases.

TABLE 79.—*Comparative occurrence, measles, German measles, and scarlet fever, in a selected group of camps in the United States, 1917 and 1918. Ratios per 1,000*

Camp	1917			1918		
	Measles	German measles	Scarlet fever	Measles	German measles	Scarlet fever
Beauregard, La	461.69	1.26	0	26.74	0.33	0.19
Bowie Tex	444.72	3.97	.27	2.93	.06	.42
Cody, N. Mex	41.86	176.18	2.56	12.52	2.67	2.36
Lewis, Wash	12.67	114.82	8.67	23.67	10.67	12.69
Pike, Ark	477.47	.12	34.26	74.11	.25	5.71
Sevier, S. C	371.40	2.94	0	33.66	1.89	2.03
Travis, Tex	452.65	2.23	.82	19.77	.37	.53
Wheeler, Ga	508.86	3.30	.35	4.27	.26	.16
Wadsworth, S. C	.87	9.58	.11	16.63	10.38	1.22
Total for camps	120.92	21.20	2.69	22.58	3.44	2.48

PROPHYLACTIC MEASURES

There are no known specific prophylactic measures for German measles. Separation of soldiers from their commands and isolation until all evidences of the disease had ceased were the bases of prevention used during the war. The incubation period is the best index for handling contacts.

TREATMENT

There is no known specific treatment for German measles. There is no record of any special work along these lines during the World War. The disease is mild, as a rule, and symptomatic treatment, in general, usually suffices. The treatment of complications is entirely symptomatic.

REFERENCES

(1) Annual Report of the Surgeon General, U. S. Army, 1920, 167.
(2) Ibid., 1919, Vol. I, 877.
(3) Geiger, J. C.: Epidemic of German Measles in a City Adjacent to an Army Cantonment. *The Journal of the American Medical Association*, Chicago, 1918, lxx, No. 24, 1918.
(4) Vaughan, Victor C.: Epidemiology and Public Health. C. V. Mosby Co., St. Louis, 1922, 179.
(5) Annual Report of the Surgeon General, U. S. Army, 1919, Vol. I, 878.

CHAPTER XV

ENCEPHALITIS LETHARGICA [a]

Encephalitis lethargica may be defined as a subacute infectious disease of the sensory nervous system, occurring sporadically in man, characterized clinically by the triad syndrome, lethargy, cranial nerve palsies, and a febrile state, and pathologically by multiple inflammatory foci most commonly in the brain stem, subthalamic region, about the third ventricle, iter, and mesencephalon.

The World War period marks the origin of the term "encephalitis lethargica" and the beginning of our present conception of this disease. Profound and prolonged sleep, however, has been observed in connection with many epidemics of influenza since early times.

In 1917, von Economo [1] described 13 cases that had been admitted to his clinic with headache, lethargy, and cranial palsies. He differentiated between the somnolence of brain pressure and that of encephalitis, remarking that in the light cases it is striking how similar the somnolence is to physiological sleep, since the patients are easily awakened. Von Economo described the cases and designated the disease "encephalitis lethargica."

While outbreaks of encephalitis lethargica (Schlafkrankheit) and "nona" have been connected with epidemics of influenza, the exact etiological relationship has not been satisfactorily explained. The World War occurrence, referred to by von Economo, appeared first in central Europe, thence spread into Germany, France, and England, in early 1918, and to the United States in the fall of the same year. Siemerling [2] reported 15 cases. The cases occurred in or in the neighborhood of Kiel, between the end of November, 1918, and April, 1919. This author observed the same symptoms noted by von Economo, and considered his cases to be the same disease.

In the spring of 1918 it appeared in France and England. Netter,[3] working in France, confirmed von Economo's findings, giving a detailed history of the disease in 10 adults and 10 children. He expressed the opinion that it is a maladie autonome, the specific agent of which is endowed with an affinity for the nerve centers, stating further that the epidemic began simultaneously in France and England late in January. In England the disease was confused with botulism and poliomyelitis. References were made to the disease as "Acute infective ophthalmophlegia, or botulism" by Harris,[4] and as "toxic ophthalmophlegia associated with acute asthenia and other nervous manifestations" by Hall.[5] Some 107 cases were reported in England and 121 in the provinces, mostly in March, April, and May, 1918. The subject was eventually taken in hand by the British Government and a complete investigation made.[6] Evidence was brought forward establishing the disease as a distinct entity and differentiating it from poliomyelitis.

As further evidence of distribution, Morguio [7] described an occurrence in Uruguay, and Arden-Delteil [8] in Algeria.

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[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

The first case of encephalitis lethargica in the United States on which any data are available occurred in the city of New York on September 4, 1918.[9] Three additional cases were reported there during the following month. The portal of entry into North America is not known. However, during the latter half of 1918 the disease spread rapidly throughout the United States, and by May, 1919, cases had been reported from 20 States, the largest numbers occurring in Illinois, New York, Louisiana, Virginia, and Ohio. During that time 255 cases were reported.

Encephalitis lethargica is not a reportable disease in many of the States and reports of its prevalence received by the United States Public Health Service are fragmentary. Some States do not report cases, while others record the cases which come to the attention of the State health officers. The United States Public Health Service has not considered it worth while to collect these fragmentary reports and tabulate them, since they would not show the real prevalence of the disease; therefore, the total incidence in the United States for the World War period can not be given. Because the disease is not found separately in the lists of disease published prior to 1920, the Bureau of the Census reports no deaths due to this cause; however, during that year, 1,070 deaths were reported in the registration area of the United States.[10]

The first cases, so far as could be ascertained, among American troops in the United States occurred at Camp Lee, Va., early in November, 1918. These cases, 8 in number, 2 among officers and 6 among enlisted men, were later reported by Pothier.[11] Since the diagnosis encephalitis lethargica did not appear on the list of diagnoses as published by the Surgeon General until 1920, the statistical tables for the World War do not include the disease under this designation. Therefore, it is not possible to give the total occurrence in the Army during that time; however, among the clincial records of World War patients it is found that there were a number of primary admissions with the diagnosis encephalitis lethargica, later classified under encephalitis. Examination of these clinical records shows 20 to have been encephalitis lethargica; 8 occurred in the United States and 12 in the American Expeditionary Forces. The cases occurring in the American Expeditionary Forces were 11 white and 1 colored, and in the United States, 7 white and 1 colored. Of these 20 cases, 4 died, 7 were returned to duty, 7 were discharged on account of disability; the disposition of the remaining 2 could not be determined. Of the deaths, 2 occurred in the United States and 2 abroad.

ETIOLOGY

Several theories have been advanced to explain the cause of encephalitis lethargica. In England it was first thought to be botulism or, perhaps, due to a poison, as solanin accumulating in the sprouts of potatoes and other vegetables. This theory was exploded by the findings of the British Government Local Board.[12] It has been suggested to be a form of poliomyelitis.

Encephalitis lethargica belongs to the class of polyencephalitic diseases and it has been suggested that the relationship to anterior poliomyelitis may be similar to that of paratyphoid to typhoid fever.[6] The influence of lowered resistance, due to war conditions, and, as a result, the possibility of saprophytic organisms becoming pathogenic, was stressed.[6] Breinl,[13] reporting upon the

"mysterious disease" in Australia, expressed the opinion that it was an aberrant form of acute poliomyelitis. Neal,[14] on the other hand, thought it improbable that encephalitis lethargica is a form of poliomyelitis.

The only epidemics of encephalitis lethargica of the past have been in connection with epidemics of influenza. The association of these diseases formed the basis of many recent investigations. Siemerling[2] attempted to associate his cases with the 1918 epidemic of influenza. Most of the cases gave a previous history of influenza. Smith[9] remarked that almost all outbreaks have been preceded by influenza. Bassoe[12] suggested that encephalitis may be a cerebral form of influenza, that the infection is akin to the virus of poliomyelitis, but not identical with it, and that nearly all cases are seen in persons more or less in a run-down state or exhausted. Hershfield[15] reported 15 cases, 3 of which gave a distinct history of previous influenza attack. Twenty-five of Neal's 38 cases [14] and half of Pothier's cases[11] gave a history of a previous attack of influenza.

It must be acknowledged that the relationship of these two diseases has not been definitely determined. According to Zinsser[16] the relationship to influenza is vague; but it is to be seriously considered, in view of the recent researches with influenza and filterable viruses in encephalitis.

In one of von Economo's cases, an emulsion of the brain and cord was injected subdurally into a monkey by von Wiesner.[17] The animal died 46 hours later in stupor. The brain is reported as having been typical of hemorrhagic encephalitis from which von Wiesner recovered a Gram-positive diplococcus. This he cultivated and, on injection into apes, produced somnolence and mental weakness. The reports of these investigators led other scientists to search for the cause of epidemic encephalitis. Strauss, Hirshfeld, and Loewe[18] obtained nasopharyngeal mucus of fatal cases, passed it through Berkefeld candles and injected rabbits both subdurally and intracranially. They claim to have produced the disease in these animals. Similar results were obtained with a rhesus. The monkey developed lethargy, general malaise, temperature, and ptosis of the left eyelid, but recovered. Rabbits, intracranially injected, died in from four to five days with punctate hemorrhages in the brain, intense congestion, marked meningitis, and mononuclear infiltrations about the vessels. The authors claim to have repeated these experiments many times. Loewe, Hirshfeld, and Strauss[19] report a filterable virus obtained from the nasopharyngeal mucus of a fatal case. The virus is reported as being capable of producing lesions in monkeys and rabbits similar to those found in the human brain. The virus has been carried through four generations in rabbits, transmitted to a monkey in the fifth generation, and then brought back to rabbits. The cerebrospinal fluid of a fatal case caused the disease in rabbits, and transfers from brain to brain through filtrates have been successful in four generations. They suggest a possible connection between the disease and influenza.

Experimental inoculations were carried out at the Army Medical School, Washington, D. C., with fresh material from one of Wegeforth's cases.[20] The spinal dura was opened 28 hours after death in one case and aerobic cultures were taken from the subdural and subarachnoid spaces. These cultures were

negative. Specimens were also taken from three levels of the spinal cord, macerated, filtered, and injected into a monkey intracerebrally, into another monkey by lumbar subarachnoid injection, into a rabbit, a monkey, and a mouse intraperitoneally. None of these animals became sick and the cultures were negative. From a patient 11 days after the earliest symptom of the disease disappeared, the spinal fluid was removed and injected into a monkey by lumbar inoculation, and into a rabbit by cysterna magna inoculation. An additional rabbit was injected into the cysterna, with this fluid and in addition with horse serum to produce a sterile meningitis. All of these animals remained unaffected

Evidence of direct communicability from man to man is lacking. An analysis of the available records from stations where the disease was reported in the Army shows no evidence of communicability.

Among the factors which may influence the occurrence of the disease, season, age, and sex are of interest. The apex of occurrence in the United States among Smith's cases was in March.[9] Skversky's cases in the American Expeditionary Forces occurred during January, February, and March.[21] Fairbanks [22] states that March and April showed the greatest prevalence.

The age incidence is of importance from a differential diagnostic viewpoint between anterior poliomyelitis and encephalitis lethargica, the former occurring more commonly among children under the age of 7 and the latter more commonly in persons older than this. Of course, the occurrence in the Army would fall entirely in the latter class.

PATHOLOGY

Characteristic lesions are confined to the central nervous system. Multiple inflammatory foci are found, particularly in the region of the basal ganglia, lateral ventricle, and about the aqueduct of Sylvius, also about the pons and medulla. Macroscopically there is usually only evidence of congestion of the meninges and cortex, with more or less edema. On sectioning the brain, and especially sections through the basal nuclei, peduncle, pons, and medulla, punctate hemorrhages are found. Microscopically miliary hemorrhages are very numerous. Neal [14] describes the lesions as mainly of three kinds: (1) Infiltration, especially of the walls of the vessels (lymphocytes and plasma cells), to a less extent in other areas; (2) hemorrhages of varying size in both the white and gray matter; (3) lesions of the nerve cells—some degeneration of the ganglion cells.

Wegeforth and Ayer [20] report the pathological findings of four cases as follows:

> The pathology of these four cases of so-called "lethargic encephalitis" was presented with a varying degree of completeness. The brains all appeared alike. A great degree of engorgement of all vessels was conspicuous; moreover, the pia was noted as pinker than normal, and this is explained by the free blood present in the meninges. The brains were abnormally soft to touch. In every case the chief seats of the lesions were the brain stem and the basal ganglions. The important lesions may conveniently be divided into (1) perivascular exudation and (2) diffuse infiltration of parenchyma. While both types of lesions vary greatly in intensity, extent, and symmetry, they were seen especially in the gray matter about the canal, fourth ventricle, and aqueduct, though deeper tissues were also affected and white matter was not spared. The cells concerned in both types of lesion were all mononuclear; a small mononuclear cell and a large mononuclear cell, frequently phagocytic, many

of which appear to be neuroglia cells, together with the lymphocyte and plasm cells, were recognized. Polymorphonuclear leukocytes were conspicuous by their absence even in the case of short duration. Mitotic figures appeared in small numbers both in the perivascular and in the diffuse exudate. That the two processes were interrelated is apparent from the appearance of diffuse exudate chiefly in the immediate neighborhood of affected vessels. That the diffuse infiltrating exudate was not necessarily related to a destructive process is borne out by the normal or only slightly changed appearance of nerve cells in its midst; however, when the exudate was excessive, marked nerve cell changes, including neurophagia, resulted. Bacteria were sought for with care and none was seen.

Lesions that may be considered subsidiary in our cases were hemorrhage and meningitis. Hemorrhages were few in number and very small, so insignificant, in fact, that they utterly failed of detection in the gross examination. However, a certain amount of free blood and fibrin, mixed with the perivascular exudate, was frequently seen. Blood vessel changes were of two types. There was almost constantly evidence of proliferation of the intima in vessels in areas of exudation, those in unaffected territory usually showing no abnormality. The second type of lesion noted was infiltration of the vessel walls (especially intraadventitial), with mononuclear cells, chiefly lymphocytes and plasma cells. This condition was observed by itself in the meninges and associated with perivascular exudate in the substance of the brain. It is likely that more of the exudate was intramurally situated than appearance indicates; this would explain the very moderate cellular infiltration of the meninges and associated low cell count in the spinal fluid. The cord and organs in the cases examined appeared essentially normal. It is unfortunate that no notes on the root ganglions are available. Lesions in the cerebral cortex were in all either nonexistent or negligible.

SYMPTOMS

For purposes of description, the symptoms may be divided arbitrarily into three stages, namely, the prodromal stage, stage of active manifestations, and state of convalescence. The prodromal stage is manifested by a more or less sudden onset, with dull headache, drowsiness, variable febrile manifestations, sometimes diarrhea, nausea, and vomiting, with or without cranial nerve symptoms. The duration is ordinarily short, commonly two to five days. It merges into the stage of active manifestations when the triad syndrome, lethargy, cranial nerve palsies, and the more marked febrile state are present. Disturbance of vision and diplopia, ophthalmoplegia or paralysis of the oculomotor nerve, ptosis, rigidity of the neck muscles, vertigo, dysphagia, aphonia, and the more marked lethargic state characterize this stage. Twitching of the body or face and an ataxic gait, resembling Parkinson's disease, are often described. Sensory changes are but seldom described in the literature. The duration of this stage is variable, lasting from one to several weeks. It is true of this stage that confusion with anterior poliomyelitis, on the one hand, and brain tumor, on the other, exists.

The stage of convalescence is marked by improvement in the lethargic state, normal temperature, diminution or disappearnce of the cranial nerves palsies, tremor, and ataxia.

Wegeforth and Ayer [20] remarked that it was unusual to find signs of organic nerve disease in the first week. In the second week, sometimes later, widespread neurological disorders became evident, with cerebral symptoms. Drowsiness occurred in almost every case, sometimes developing into coma, and at times alternating with irritability or anxiety. However, orientation and cerebration were usually uneffected until just before death. The long projection nerve fibers showed profound disturbance in seven of their cases, as indicated

by ataxia, spasticity, Babinski's reflexes, and clonus. Diplopia was present in seven cases, although oculomotor palsy was seldom actually seen. The second most frequent local disorder was weakness of the facial muscles, usually unilateral, and seen in five cases. Pupillary disturbances and irregularity, inequality, and abnormal reaction were common. Weakness of the jaw muscles was observed three times, while profound disturbance of respiration was twice noted. They make special emphasis of the clinical manifestations—insidiousness of onset, recurrent and incomplete paralysis, and implication of cerebral nerves confined to motor functions. Skversky [21] reported two of his cases as showing a fairly well-marked Parkinsonian picture. In 9 out of 10 of his cases there was a definite febrile period either preceding, or concomitant with, the attack of encephalitis lethargica, that included coryza, mumps, bronchopneumonia, and in one case possibly paratyphoid B. Before admission, the following symptoms were complained of: Headache in 5 cases; diplopia, 2; dysphagia, 1; temperature, 4; mental dullness, 6; and an unsteady gait in 1. After admission, 4 cases showed involvement of the third and seventh cranial nerves. Nystagmus was present in 3, masked face, 5; tremor, 5; insomnia, 2; slow speech, 3; and the pill-rolling movement in 1 case. Spaeth,[23] reporting on ocular symptoms of encephalitis, observed in 5 cases, showed reduced pupillary reaction to light in 3 and to accommodation in 4; diplopia was complained of in 3 cases; dilatation was present in 3 and irregularity in 1.

Hershberg [24] reported involvement of the third, sixth, seventh, and ninth nerves in his patient at Base Hospital No. 69, A. E. F. There was deviation of the uvula to the right. The Kernig and Babinski reflexes were absent. Nystagmus was present and the eye grounds were negative.

It was the lethargic condition in persons suffering from this disease that suggested the diagnosis "sleeping sickness." Bassoe [12] stated that there is not so much real sleep as is indicated by the sleepy expression. In fact, some patients suffer from insomnia and the lethargy bears almost the same relation to sleep that laughter of the pseudobular paralysis patient does to the normal laugh. Vaughan [25] held that the stupor is partly apparent and partly real.

Blood findings were reported upon as being negative. A mild leukocytosis was occasionally present, but often nothing of diagnostic value. In like manner, the spinal fluid showed no characteristic change.

COURSE AND PROGNOSIS

The course and ultimate results are extremely variable. Some cases run a rapid, mild course, ending in from two to three weeks with apparently complete recovery. Other cases run a stormy course, terminating in death in a few days, while some show a slow convalescence extending into months and leaving the individual permanently incapacitated. Skversky,[21] discussing the slow convalescence, stated that it often requires months and then leaves the individual with an unsteady gait, general weakness, a masked face, etc. Hershfield [15] reported the duration of the active stage from 6 to 60 days, with an average of 32 days. It is difficult to prophesy as to the residual disturbances. A spastic gait, paralyses of the limbs, speech difficulties, and mental and emotional instability have been reported. Fairbanks [22] reported that opthalmophlegia and facial

paralysis may clear up on one side before attacking the other, and that either form of paralysis may clear up and then recur. This author further reported that the mergence from lethargy and the restoration of general health is extremely slow. Duration of the clinical phenomena is so variable and convalescence so prolonged that it is difficult to give even an average duration of the affection. Eliminating the abortive cases, it is safe to state that six weeks is the minimum duration. In the majority of cases many weeks, even months, may pass before full restoration to health—if it occurs—is achieved. Impairment of intellect may remain. Among other sequelæ, tremor and disturbance of coordination are conspicuous. The tremor may be of the paralysis agitans type, or it may be of a finer degree and either general or confined to the extremities. Ataxia is commonly of the cerebellar type, but is also frequently present for fine movement of the fingers. Disturbances in swallowing, or in speech, may be more or less noticeable for a long time, yet are rarely persistent. According to Fairbanks,[22] the lack of emotional expression in the face often extends over a long period.

As previously stated, a study of the cases in the Army during the World War can be only fragmentary. An analysis of 20 clinical records shows 2 deaths in the United States among 8 cases, and 2 deaths among 12 cases in the American Expeditionary Forces. These 20 cases are the only ones that permit of detailed analysis. The records show that 7 were returned to duty, 7 discharged from the service on account of disability, 4 died, and 2 were unaccounted for. Among the cases returned to duty, the duration of hospitalization varied from 18 to 115 days, an average of 53.3 days. Among those discharged on surgeon's certificate of disability, the period of hospitalization varied from 32 to 329 days, an average of 180 days.

DIAGNOSIS

Diagnosis usually can be made by the more or less sudden onset with lethargy, cranial nerve palsy, practically normal blood and spinal fluid findings, with febrile manifestations, and the absence of sensory, trophic, and meningeal irritation symptoms. This disease has been confused with others, notably botulism poliomyelitis, tubercular meningitis, myelitis, brain tumor, and brain abscess.

The strong clinical, epidemiological, and pathological evidence that encephalitis lethargica is a distinct disease from classic poliomyelitis is supported by animal experimentation.

The symptoms of tuberculous meningitis may simulate those of encephalitis lethargica. Fairbanks [22] remarked that it may be impossible to differentiate the two and may require post-mortem findings to overcome the doubt. An onset with meningeal symptoms and pinched facial expression so characteristic of tuberculous meningitis is strongly suggestive. The results of lumbar puncture showing increased pressure, pleocytosis of mononuclear cells, and formation of the pellicle on standing, taken along with the finding of tubercle bacilli on microscopic examination (or after animal inoculation), would confirm the diagnosis.

Myelitis is differentiated by the presence of sensory, trophic, and sphincter changes, possibly optic neuritis, and absence of the cranial nerve palsies; furthermore, lethargy is not usually seen in myelitis. Although fatal cases run a

short course and often die of respiratory failure, this failure is due to paralysis of the muscles of respiration. Respiratory paralysis is a common cause of death in encephalitis lethargica. When it occurs, it is due to involvement of the respiratory center.

In brain tumor, the onset is usually more gradual, there is absence of elevated temperature and usually presence of optic nerve changes from pressure, as well as localizing symptoms. These latter, however, may be absent if the growth is located, for example, in the frontal lobe. As previously stated, one case discharged from the service on account of disability was diagnosed encephalitis lethargica, later changed to psychoneurosis, and then to brain tumor.

PREVENTIVE MEASURES AND TREATMENT

In the absence of any evidence of direct communicability, and in the absence of recognized etiology, nothing is known of the prophylaxis in this disease. So far as the records would indicate, there were no steps taken during the war to prevent its spread. As previously mentioned, there was no discoverable connection between the occurrence of one case and another that would point to direct or indirect transmission.

Treatment was symptomatic. Most authors agree that spinal puncture is advisable. Some seem to think that a release of spinal fluid is beneficial and should be repeated. At any rate, it serves a valuable purpose in diagnosis. No specific or prophylactic treatment is known or was developed during the war period.

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CHAPTER XVI

INFECTIOUS JAUNDICE; TYPHUS FEVER; TRENCH FEVER [a]

INFECTIOUS JAUNDICE

Infectious jaundice is not a new disease, epidemics having been reported upon as far back as the first half of the eighteenth century.[1] In 1914 certain Japanese investigators isolated a spirochete from cases in their own country to which they gave the name *Spirochæta icterohæmorrhagiæ*.[1] The intermediate host of the parasite is the brown rat. This spirochete is to-day generally accepted as the specific cause of the disease.

The United States Army reported a total of 452 cases of spirochetal jaundice during the period of the World War, with a resultant loss of 9,251 days and 15 deaths. The distribution of these cases by countries is indicated in the following table: United States, 279; Europe, 108; Philippine Islands, 15; Panama, 9; other countries, 5; transports, 1; total officers, 35; total Army, 452. To these 452 original admissions must be added 80 instances in which the same malady occurred concurrently with other diseases, making a grand total of 532 cases.

TYPHUS FEVER

Typhus fever has been long known, and the World War added little, if anything, to clinical knowledge concerning it. Its transmission by the louse is accepted. Its incidence in the Army during the World War was as follows: United States, 15; Europe, 7; other countries, 19; officers, 1; total, 42. To the 42 original admissions for typhus fever must be added 5 more cases in which this malady appeared as a concurrent disease. Three of these individuals died and the disease was responsible for 1,335 days lost.

Although the war did not, properly speaking, advance in measurable degree the clinical, epidemiological, and etiological phases of the available knowledge concerning typhus fever, nevertheless, the startling epidemics of the disease which occurred in Russia, Poland, and other countries during the war period served to stimulate the labors of the Typhus Research Commission of the League of Red Cross Societies to Poland, the results of whose investigations became available in the main report of this commission which appeared in 1922.[2] This commission looked upon "the determination of the exact nature of the specific cause of the disease * * * as the most important goal."[2]

The transmission of typhus fever by the louse was accepted at the start. The one organism found to be most definitely and uniformly demonstrable in lice that had fed upon typhus patients was *Rickettsia prowazeki*. This Rickettsia was identified in each instance upon its appearance as observed in serial sections of lice. It was found in the lice of 27 out of 52 experiments.[3] Changes in technique based upon experience secured positive results in practically every one of the last third of the experiments.

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[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

Rickettsia pediculi was found occasionally. Microorganisms other than Rickettsia did not appear in any of the 52 experiments in which lice were nourished upon typhus patients. Animal experimentation designed to prove *Rickettsia prowazeki* the specific cause of typhus fever is reported in detail. The authors' conclusions are as follows: [4]

The presence of *Rickettsia prowazeki* in lice in our experience is proof of the presence of the virus of typhus.

A variable percentage only of lice nurtured upon typhus patients acquire the virus of typhus; and this holds true in boxes where all lice have equal opportunities to become infected.

After allowing for the technical difficulties in making adequate search for Rickettsia and injections from the same louse and for the uncertainty of the reaction of guinea pigs to typhus blood in the test for immunity, we believe that the data from the above experiments are sufficient proof that the virus of typhus and *Rickettsia prowazeki* are inseparable.

Concerning Rickettsia, it is stated [5] that this "is the group name given by da Rocha-Lima (1916) to minute microorganisms with certain peculiarities found in lice. The name honors the memory of Howard Taylor Ricketts, who first described microoganisms possibly of this type in connection with studies upon typhus (Ricketts and Wilder, 1910)." The present knowledge of Rickettsia is summarized as follows: [6]

A satisfactory definition of Rickettsia is not possible at present. The properties in common of the 13 or 14 microorganisms so far described under this name are as follows:

Morphology.—Bacteriumlike on the whole. They are smaller than bacteria and occur characteristically in pairs. Large forms, bacillary and filamentous, have been described in connection with two carefully studied Rickettsias—*Rickettsia prowazeki* and *Rickettsia lectularius*—and it seems probable that a simple cycle or sequence in morphological development is a characteristic of the pathogenic forms.

Staining reactions.—Difficulty of staining with the common staining solutions used for bacteria is a striking feature, as is the failure to retain the stain by Gram's method. The only satisfactory staining methods are the modifications of Romanowsky's method; of these, the most satisfactory is Giemsa's solution.

Mobility.—Motile forms have not been seen.

Cultivation.—So far all have resisted cultivation with the exception of the Rickettsia from the sheep louse. It grows on a relatively simple glucose blood agar medium.

Resistance to physical and chemical agents.—Not enough work has been done to generalize. The viruses of typhus (da Rocha-Lima, 1919, p. 240) and Rocky Mountain spotted fever (Wolbach, 1919) are extremely susceptible to heat, drying, and chemical agents. On the other hand, the virus of trench fever resists 80° C. of dry heat for 20 minutes and drying for many months (Byam and Lloyd, 1919).

Host specificity.—All Rickettsias have insect hosts which in the case of the pathogenic ones are the vectors. All are highly specific for their insect host, while the pathogenic ones may infect widely separated mammals.

Hereditary transmission.—In every instance where careful study has been made it has been found—with the exception of the Rickettsia of typhus—that the organisms pass down through successive generations in the eggs. Da Rocha-Lima has offered some evidence that this is also true of *Rickettsia prowazeki*, and Sergent, Foley, and Vialette, 1914 (quoted by Nuttall, Parasitology, vol. 10), accidentally communicated typhus to a monkey and a a man with the offspring of lice which were supposed to be infected only with relapsing fever.

Classification is of course impossible, and it is probable that we have already included under Rickettsia a number of very different microorganisms. The Rickettsia of the sheep louse has little to distinguish it from bacterium; yet we believe the Rickettsia of typhus has a number of peculiarities which necessitate its separation at present. The Rickettsialike

cause of Rocky Mountain spotted fever, which we prefer for the present to consider under a distinctive name, while resembling in many ways *Rickettsia prowazeki*, is very unlike the morphologically simple Rickettsia of trench fever.

At the present the opinion seems generally held that *Rickettsia prowazeki* is the specific cause of typhus fever. This knowledge may be credited to the epidemiological opportunities indirectly afforded by the World War.

TRENCH FEVER

In 1915 there made its appearance among British troops on the Western Front a disease[7] which came to be known as "Trench fever"[8] and which gradually was recognized as a specific infection. The armies in Salonika likewise reported cases of this disease.[9] There is no available evidence indicating that this disease had ever been recognized as a clinical entity before 1915.

OCCURRENCE IN THE ARMY

The following figures, which represent the occurrence of trench fever in the Army, include a number of experimental cases, but do not embrace relapses from either experimental or natural causes. The total number of primary admissions was 798, divided as follows: Officers, 54; white enlisted men, 531; colored enlisted men, 2; color not stated, 211. All of these cases, except 12, occurred in our forces in Europe; the 12 cases were admitted in the United States. To the 798 primary admissions are to be added 103 cases which were concurrent with other diseases for which admission was made, thus giving a total of 901. Among these, there were 2 deaths, 1 white enlisted man and 1 color not stated. Both deaths were in Europe.

The foregoing figures suggest a point of interest as regards the racial distribution of this disease. The admission rate per 1,000 was, for white enlisted men in the whole Army, 0.15, as against 0.01 for colored enlisted men; and in Europe 0.35 for white enlisted men and 0.02 for colored enlisted men. Assuming the probability that essentially the same conditions as to louse infestation obtained in both white and colored combat troops, this notable difference in race incidence would seem at first glance to indicate a relatively higher immunity on the part of the colored man. On the other hand, colored troops had relatively much less service in the trenches than did white troops, and it is probably much nearer the truth to assume that lice infected with the virus of trench fever were largely, if not wholly, confined to the combat areas.

ETIOLOGY AND TRANSMISSION

The researches of the trench fever research committee of the American Red Cross[b] whose report was issued in 1918 afforded at the time of publication the last word on the etiology and transmission of this disease.[10] For the investigation of the problems concerning the etiology and transmission of the disease, human subjects were necessary, since the disease was not transmissible to animals. The consent of the commander in chief, A. E. F., to the use of soldiers

[b] The members of the commission were as follows: Maj. Richard P. Strong, M. C.; Maj. Homer F. Swift, M. C.; Maj. Eugene L. Opie, M. C.; Capt. Ward J. MacNeal, M. C.; Capt. Walter Baetjer, M. C.; Capt. A. M. Pappenheimer, M. C.; Capt. A. D. Peacock, R. A. M. C. (T); and Lieut. David Rapport, M. C.

who might volunteer for this human experimentation was secured by the chief surgeon, A. E. F., Out of hundreds who volunteered, 82 were selected. All these volunteers were subjected to detailed physical examination to exclude any unfit, and bacteriological examinations were then made of the blood, urine, and feces to eliminate those who might be suffering from chronic infections, and carriers. The whole detachment was strictly segregated, and the most complete records as to temperature and condition of skin and clothing were made. A semiweekly bath and weekly sterilization of clothing were a part of the routine.

In seeking the specific etiological factor, the first step was an inquiry into the possibility of infection with any members of the enteric group of bacteria. Briefly, the examinations of blood, urine, and feces in cases of spontaneous and experimental trench fever by methods adopted in the search for the typhoid and paratyphoid bacilli were consistently negative. Serological reactions gave no indication that any of these organisms was culpable. Structures resembling spirochætes had been previously found by at least one worker on the hematology of trench fever.[11] He looked upon the possibility of their being the causative factor in the disease as not incompatible with the filterability of its virus since "some spirochætes are known to be filterable * * *." Otherwise the search for spirochætes in the blood (as conducted by the members of the Red Cross commission by the method of anaerobic cultures) was entirely unsuccessful. The Wassermann test likewise was consistently negative, and thus failed to give any suggestion that trench fever might be a modality of syphilis, or due to any spirochæte of close biological relationship to *Spirochæta pallida*. The commission confirmed the earlier experiments of McNee, Brent, and Renshaw that the disease was infectious and transmissible by the blood. Thirty-four volunteers who previously had been studied with great care were inoculated with blood or some constituent portion thereof taken from trench fever patients during the febrile paroxysms. Of these, 23 contracted the disease with an incubation period of from 5 to 20 days. Careful consideration of the results of experimental inoculation brought the commission to the conclusion that "The virus or organism of trench fever is present particularly in the fluid portion of the blood, and is not contained within the blood corpuscles themselves."

Investigation of the filterability of the virus resulted in proof that "at least one stage of the development of the virus of trench fever is filterable and ultra-microscopic," though elsewhere it is stated that the "virus is not filterable with ease in centrifuged plasma or serum."

Concerning the thermal death point of the virus, it was found that the virus resists a temperature of 60° C. moist heat for 30 minutes, and is fully virulent after such treatment, but is killed by a temperature of 70° C. moist heat for 30 minutes. Obviously, therefore, a temperature of 55° C. for 30 minutes, which destroys the *Pediculus humanus* and its ova, does not suffice to destroy the virus of trench fever which may be present on the underclothing of trench fever patients. Furthermore, its stability is perhaps one of its most striking characteristics. Immediate suspension of the thoroughly dried virus in a large volume of saline solution for several hours does not attenuate its virulence, and it has already been pointed out that it resists drying in the urinary

sediment of trench fever cases and in louse excrement. For these reasons the organism causing trench fever may apparently be most appropriately classified as a resistant filterable virus. The virus is invariably present in the blood in the early stages; it is not present in the feces; it is present in the urine; sometimes it appears to be present in the mixture of saliva and sputum, as indicated by successful inoculation experiments.

Thirty-eight of the 82 volunteers were employed in experimental investigation of the transmission of trench fever by the louse. A pure-bred strain of lice was obtained from the Lister Institute for this purpose. The so-called "box method" of handling these lice was made use of. When lice were to be allowed to feed upon trench fever patients the small, round, cardboard box in which they were confined was placed, after removal of the cover, upon the surface of the skin of the forearm. The period of feeding was in each instance not less than 30 minutes and was repeated three times a day. Lice were placed upon healthy volunteers at varying intervals of time after removal from the patients, with intent to exclude direct mechanical transmission through the medium of the parasite's biting mouth parts, and as well to obtain information with regard to the length of time the louse might remain infective. These experiments led to the conclusion that the disease "is transmitted naturally by the louse, *Pediculus humanus*, Linn., var. *corporis*, and that this is the important and common means of transmission; that the louse may transmit the disease by its bite alone (the usual manner of infection), or the disease may be produced artificially by scarifying the skin and rubbing in a small amount of the infected louse excrement." Also "that a man may be entirely free from lice at the time he develops trench fever, the louse that infected him having left him some time previously as its host, and that the louse need only remain upon the individual for a short period of time in order to infect him." It was furthermore shown that no evidence could be obtained pointing to the hereditary transmission of the virus of trench fever in the louse; and finally there is evidence that, if the virus undergoes development in the louse, it requires 6 to 10 days to do so; there is a little evidence that suggests the minimum incubation period to be about 4 days and that "lice may remain infected for at least 10 days and possibly 13."

The most suggestive discovery in all attempts to identify the specific cause of this disease has been Rickettsia bodies. Swift [12] states that "while it is difficult not to believe that there is a causal relationship between the virus of trench fever and the Rickettsia bodies, it will be difficult to establish definitely such a relationship until it is possible to obtain pure cultures of the bodies and with them to reproduce the disease. In this connection it must be recalled that the relation of Rickettsia bodies to other microorganisms has not been established. They may be specific microorganisms; they may be a granular stage through which some other microorganism is passing; or, finally, they may be cell inclusions, the result of the action of some invisible virus on the cell protoplasm, and thus resemble the Guarnieri bodies in vaccinia, the Negri bodies of rabies, the molluscum bodies in molluscum contagiosum, and the cell inclusions in trachoma." Ledingham [13] succeeded in producing agglutination of Rickettsia in emulsions prepared from dried lice excreta by the use of immune

sera from four experimental rabbits and one guinea pig. He found, however, that agglutination disappeared beyond a dilution of 1 in 40.

From critical consideration of the foregoing it would seem that the final conclusion as to the specific cause of trench fever must be that it is not yet indubitably known, although available evidence now points more suggestively to a Rickettsia than in any other direction.

SYMPTOMS

The period of incubation in louse-borne trench fever varies from 14 to 30 days, though the suggestion is offered that this might be shortened in cases of infection resulting from large amounts of virus.[10] Certain vague prodromata—headache, fever of a low grade, and pain in the extremities—are complained of by a minority of individuals. Otherwise the onset is sudden and characterized by dizziness, headache, retrobulbar pain, particularly on movement of the eyeballs, nystagmus when the eyes are directed to either side, conjunctivitis, and a sudden elevation of temperature to 103° or 104° F. The febrile reaction varies much in its characteristics. It may last about a week, to be followed by a period of defervescence and a short relapse, or it may persist for several (often six) weeks and be marked during that period by indefinite relapses; and, finally, it may assume quite distinctively the form of a regularly relapsing fever with apyretic intervals lasting six or seven days. A less frequent picture is that of a low continued fever which persists, with only slight remissions, or none at all, from one to two months. The skin in three cases out of four presents an eruption consisting of erythematous spots or papules, most intense on the ventral and dorsal surfaces of the torso. The individual lesions average 3 or 4 mm. in diameter, are pink in color, and the color disappears under pressure. The period of their duration is short, often no more than 24 hours. Most characteristically they first appear during the initial stage, but they are sometimes first seen during a relapse.

The blood picture is variable. Many cases show a moderate leucocytosis (13,000 to 17,000), which recurs with each relapse. On the other hand, in certain cases the leucocytes are normal, while a few manifest a leucopenia (occasionally as low as 3,500). The urine frequently contains albumin in small amounts, but there is no other evidence of true inflammation of the kidney. The spleen is enlarged in a considerable majority of instances.

The most impressive subjective symptoms of trench fever are pain and tenderness. These are referred particularly to three regions or systems—the bones, the head, and the muscles. The "shin pains" are present in 75 per cent or more of all patients. They are boring or lancinating in character and increase in severity so much at night as seriously to interfere with sleep. They appear most characteristically on the third day of the disease or later, but in certain cases do not occur until the first or second relapse. They are accompanied by marked tenderness of the tibia to pressure. Pain of a similar character occurs in the scapula in many cases. Joint pains occur with a frequency equal to that of shin pains in both the upper and lower extremity. The headache is a universal symptom. It is commonly frontal or postorbital, though it may be generalized, and it lasts for two or three days, usually recurring with

each relapse. It is accompanied by a peculiar tenderness to pressure in the supraorbital region which occasionally involves the entire scalp.

Muscle pain is complained of in the lower extermities, in the abdominal wall (either localized or generalized), in the lumbar region where it occurs in 80 per cent of all cases, in the muscles of the shoulder girdle, and in the cervical muscles. It is accompanied by tenderness on palpation.

Anorexia and coated tongue are the most prominent of the gastrointestinal symptoms.

Although the pain is so constant and so marked and the reflexes are exaggerated, it is not believed that the central nervous system is directly attacked by the virus of trench fever. The nervous manifestations are probably no more than may be accounted for on the basis of toxemia.

The pulse usually parallels the temperature in the first stages of the disease, but later shows a tendency to acceleration. The dyspnea, tachycardia, precordial pain, increase in the size of the heart, all indicate marked involvement of that organ. It has been assumed either "that trench fever virus has a selective action on the heart muscle such as we see in rheumatic fever or in the specific infiltration in syphilis 'of the heart,' or that the 'toxin in trench fever acts upon the heart muscle in a similar way to that seen in pneumonia, typhoid fever, influenza, bronchitis, or other acute infections.' "[10]

COMPLICATIONS AND SEQUELÆ

The most important of these is concerned with the heart, and has been variously termed "effort syndrome," "disordered action of the heart," and "tachycardia." The circulatory manifestations of trench fever have already been described. The persistence of the indicated cardiac condition after the apparent cessation of activity is probably to be ascribed—at least, in large measure—to the desire of medical officers to return soldiers to duty as soon as possible. Convalescence appears to be essentially a lengthy procedure in this disease, as in dengue fever, and acceptance of such a view in the management of convalescence will allow for complete recovery without the appearance in any marked degree of this cardiac disorder. Thus, the American Red Cross commission, previously quoted, states that—

> Among our patients, we feel that up to the present time none have shown a condition of D. A. H. after the infection was overcome. This probably is due to the fact that our subjects were carefully chosen, and those who had previously shown symptoms of cardiac weakness were not inoculated. The subjects were all young and strong, and at the time of inoculaton were not suffering from other infections, nor had their resistance been lowered by long duty in the trenches or exposure to other forms of strenuous work * * * On the other hand, the absence of permanent effect upon the heart may have been due to the opportunity we had of holding the patients until we felt they were fit for active duty.

Except for the cardiac complications and sequelæ of trench fever, the concurrent diseases in the Army were widely various, and were not such as to indicate a pathological relationship between themselves and the original infection.

PATHOLOGY

Since the disease uncomplicated is never fatal, and since it is not transmissible to animals, the pathology is a sealed book. The clinical evidence of changes in the heart and spleen, as well as the blood findings, have been referred to under symptoms.

DIAGNOSIS

Diagnosis is to be made upon the symptoms and signs hereinabove described, of which the shin pains and shin tenderness are perhaps the most essentially characteristic.

From influenza, trench fever may be differentiated by the absence of respiratory symptoms and signs, by the characteristic pain and tenderness, by the relapses, by the splenic enlargement, and by the eruption.

Typhoid and paratyphoid fevers are of gradual onset, are accompanied by certain digestive disorders, present a spleen which is less enlarged (if at all) and softer than is the case in trench fever, lack the characteristic pains and tenderness, show a leucopenia, and give a blood serum capable of agglutinating the causative organism in high dilution. *Bacillus typhosus* and *Bacillus paratyphosus* may also be recovered from the blood, feces, and urine.

Trench fever and malaria differ very characteristically in their temperature charts, in the matter of febrile paroxysms, in the skin eruption, pains, and tenderness which are present in the former disease, and in the absence of the malarial parasite in the blood of trench fever cases unless the two diseases coexist.

Relapsing fever, because of its mode of onset, its pain, and rash, may be confused with trench fever; but a crisis on the seventh day with a relapse at the end of another seven-day period in relapsing fever indicates a difference between the febrile processes. Both liver and spleen are enlarged in relapsing fever, the spleen alone in trench fever. The causative spirochetes are present in the blood of relapsing fever and absent therefrom in trench fever. Salvarsan exerts a marked effect upon relapsing fever, but none on trench fever.

Dengue fever may suggest trench fever in its mode of onset and distribution of painful areas, but the acute stage of dengue is short, with an intermission occurring on the third to fifth day. The rash in dengue fever is erythematous or scarlatiniform during the first paroxysm and measleslike in the second paroxysm. Dengue is invariably characterized by a marked leucopenia; trench fever presents a moderate leucocytosis in a great majority of cases.

In typhus fever the onset is more gradual than in trench fever and is accomplished in successive steps. Toxemia becomes increasingly more profound as typhus fever progresses, while the toxic manifestations of trench fever—such mild ones as there may be—are more intense within the first few days after onset and rapidly subside. The characteristic relapses of trench fever are not found in typhus fever. The skin eruption in typhus appears on the third to the fifth day and is macular in character, changing to petechial. Typhus fever has a high mortality; trench fever is never fatal.

Malta fever is to be differentiated from trench fever, first, by the different temperature curve, by the absence of the eruption and characteristics pains

and tenderness, by recovery of the causative organism from the blood and urine, and by serological methods.

There is, however, no serological or other laboratory procedure which is specific for the diagnosis of trench fever.

PREVENTIVE MEASURES

General preventive measures during the war consisted essentially in the delousing of officers and men, together with their effects, a detailed description of which is in Volume VI, Sanitation.

No attempts, apparently, were made to attenuate by heat the virus of this disease as it occurs in louse excrement and in the urine of trench-fever patients, and to vaccinate experimentally with such material. Since the infection of laboratory animals is not possible, such experimental attempts at vaccination could hardly lead to results of practical value for the reason that the source of such vaccine could only be trench-fever patients themselves, of whom a very considerable number would undoubtedly be necessary to supply material sufficient in amount for large bodies of troops. Again, no reference can be found to the attempted protection of noninfected individuals by the use of serum from convalescent patients.

The relatively small number of cases of trench fever reported for the whole United States Army can not bespeak efficiency of the preventive measures in operation among American troops, in view of the fact that the major portion of our combat troops were louse infested at the time of the signing of the armistice. But other considerations must be taken into account. A study of the statistics of trench fever in the Third Army shows that three-fourths of all its cases occurred in two divisions, as follows:[14]

Incidence of trench fever in troops of Third Army, January 1 to March 1, 1919

	Cases		Cases
42d Division	143	Third Army troops	9
2d Division	55	Third Corps troops	2
1st Division	16	Fourth Corps troops	1
52d Division	11		
4th Division	8	Total	251
3d Division	6		

Again, the Third Army alone reported within only two months (January 1 to March 1, 1919) nearly a third of all the cases in the whole American Expeditionary Forces for the entire period of the war. That these figures represent the actual state of affairs is difficult to believe. They tend to suggest rather that in reality the cases in the Army exceeded the reported number of 901, and that many diagnoses were missed either because of transfer of the infected individuals from one station to another or—more especially—"because medical officers were not acquainted with the manifestations of the disease."[14] This impression is definitely reinforced by a consideration of the far greater uniformity with which trench fever is shown to have invaded the various units of the British Expeditionary Force.

TREATMENT

No specific method of treatment is available. Salvarsan and the other antisyphilitic arsenicals are without effect. A symptomatic therapy consisting of complete rest in bed during the infectious period, a diet of good nutritive value, and the exhibition of such drugs as aspirin and Dover's powder in doses sufficient to control the pains are indicated. The most important factor in treatment is the recognition of the necessity for prolonging the convalescent period until the cardiac condition and action have become entirely normal. Patients should be kept in bed until all probability of a relapse is at an end. The amount of time allowed out of bed should then begin with a few hours and gradually be increased daily, provided no return of the cardiac symptoms is noticed. As soon as the patient reaches the point of remaining up and about all day, guarded and carefully supervised exercises are to be begun. These must be carefully controlled and the appearance of dyspnea, cardiac palpitation, dizziness, pain, fatigue, headache, excessive increase in pulse rate, and cyanosis are the signal for moderation in the amount of exercise taken. The exercises employed are of two kinds: Setting-up exercises and practice marches. As soon as the patient can endure a practice march of 5 miles with full field equipment and return therefrom without evidence of undue weakness his convalescence is looked upon as completed

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CHAPTER XVII

VINCENT'S DISEASE

Vincent's disease, as it was known during the World War, was variously designated, according to location or pathological process, as trench mouth, trench gums, trench throat, ulcerative tonsillitis, Vincent's angina, epidemic ulceromembranous stomatitis, ulcerative gingivitis, and angina necrotica. As the disease first received attention on a large scale among troops while serving in the trenches, and it was thought that conditions incident to this service at least predisposed them to infection, it was spoken of most commonly, during the war, as "trench mouth," "trench throat," and "trench gums." By some it was thought to be a new disease. All authorities are not agreed as to the origin and cause of the affection. Some contend that Vincent's angina almost invariably commences as gingivitis, acute ulcerative, sub-acute, or chronic;[1] others are of the opinion that it is not a separate entity, a disease in itself, but is a manifestation of some other process, notably syphilis. Sobernheim[2] is often referred to as authority for the statement that the Wassermann reaction is positive in Vincent's angina. Further, there is dispute as to the etiological part played by *B. fusiformis* and Vincent's spirochæta, as well as other spirochætes in the mouth, notably the *S. dentium*.

Vincent's disease is an acute or chronic, mildly contagious disease of the mucous membrane of the mouth, with occasional manifestations in the throat, bronchi, eye, and genitalia. It is characterized clinically by a rather slow or chronic onset, with a local lesion or lesions, pain in the acute form and little or none in the ulcerative, lymphadenopathy of the glands draining the area involved, offensive breath, interference with deglutition when the lesion is located in the mouth or throat, and comparatively little constitutional disturbance. It is characterized pathologically by the formation of a pseudomembrane or "punched out" ulceration, with a red bleeding base and the presence of the *B. fusiformis* and the *Spirochæta vincenti*.

The number of cases of Vincent's disease reported in medical literature prior to the war would indicate that it was rare until the widespread occurrence among troops on the Western Front, described by Bouty.[3] Investigation showed that among the British and French troops, especially in the trenches, a disease of the mouth, gums, and tonsils, which came to be called "trench mouth," "trench throat," and "trench gums," was so common that it constituted 23 per cent of all throat complaints. It was found that these conditions were associated with an admixture of fusiform bacilli and spirilla.

Before the entrance of the United States into the war, the ulcerative form of Vincent's disease was practically unknown in the Army. Rarely cases of the acute type, characterized by presence of a pseudomembrane in the throat (rarely on the gums), with severe angina and marked constitutional symptoms, were diagnosed as Vincent's angina. These cases were so few that it was not deemed necessary to record this term in the Army list of diagnoses. Soon after the arrival of American troops in Europe, cases of "trench mouth" appeared on

the sick and wounded reports and the number of reported cases of Vincent's disease greatly increased. Cases appearing under the terms "trench mouth" and Vincent's angina were tabulated and carried separately in the files; however, the statistical tables for the World War show only cases reported as "trench mouth." In this chapter both trench mouth and Vincent's angina will be considered as one and the same disease—Vincent's disease.

OCCURRENCE

IN CIVIL POPULATION

In modern American textbooks the statement is made that Vincent's disease is not common among the civilian population. Theisen[4] found that, between 1909 and 1910, 687 throat swabs were examined in the Michigan State Laboratory for diphtheria, and that 178 of the cases proved not to be diphtheria at all but were cases of Vincent's disease. Vincent himself found the disease in 2 per cent of all cases of membraneous angina. One is led to believe, therefore, that it is more common among civilians than heretofore believed.

IN ARMIES

Bouty,[3] in 1917, stated that during the two preceding years there had been a gradual and marked increase in the number of cases of Vincent's disease among the troops in France, both British and French. In times of peace the rate was from 2 to 3 per cent of all throat complaints among French troops. Chalier[5] reported 46 cases of throat conditions among 2,500 men during 22 months. Of these, 26 per cent were Vincent's disease, while Deglos[6] found 21 cases of ulceromembranous stomatitis, Vincent's disease, among 255 men sent with sore throat to his contagious hospital. The acute ulcerative form of gingivitis was found present in about 0.7 per cent of the British troops in France seeking dental treatment, and in about 0.3 per cent among soldiers living under various conditions but not reporting for dental treatment.[1]

From the available fragmentary reports, it would appear that Vincent's disease, commonly designated by German and Austrian authors as Plaut-Vincent disease, was prevalent among the German and Austrian forces. Sauerwald[7] described an outbreak of 45 cases among the German troops in 1917. These cases occurred in a hospital center and were described as Vincent's angina and noma. Sachs[8] demonstrated some cases in a military hospital in Vienna in April, 1917.

IN UNITED STATES ARMY

Table 80 shows the number of primary admissions, deaths, discharges from the service on account of disability, and days lost from duty, by country, race, and year of occurrence, for Vincent's disease during the World War. This table includes enlisted men only. It shows that the number of cases of Vincent's disease, under the designation of trench mouth, was small, the majority having been reported from Europe, while the primary admissions for what was diagnosed Vincent's angina ran into the thousands and were about evenly divided between the United States and Europe. It is of interest to note, however, that the number of primary admissions for Vincent's disease by years increased throughout the war, although the size of the Army fluctuated greatly, being considerably smaller in 1919 than during the preceding year.

TABLE 80.—*Vincent's disease. Admissions, deaths, discharges for disability, and days lost, white and colored enlisted men and native troops, United States Army, by countries of occurrence, April 1, 1917, to December 31, 1919, absolute numbers*

VINCENT'S ANGINA

Years	Total Army (enlisted men)						United States			Europe				Philippine Islands			Hawaii			China	Panama	Transports				Other countries				Native troops			
	White	Colored	Color not stated	Total American enlisted men	Total native troops	Total enlisted men	White	Colored	Total	White	Colored	Color not stated	Total	White	Colored	Total	White	Colored	Total	All white	All white	White	Colored	Color not stated	Total	White	Colored	Color not stated	Total	Filipinos	Porto Ricans	Hawaiians	Total
ADMISSIONS																																
1917	257	4	0	261	1	262	220	3	223	9			9	23	1	24	2		2	(a)		3			3					1			1
1918	1,631	63	40	1,734	0	1,734	816	41	857	788	21	39	848	7		7	2	1	3	(b)	2	3			3								0
1919	3,915	90	105	4,110	6	4,116	1,722	38	1,760	2,079	49	105	2,233	12	3	15	7		7	(b)	3	4			4	88			88	5		1	6
DAYS LOST																																
1917	2,505	35	0	2,540	9	2,549	2,165	29	2,194	57			57	254	6	260	9		9	(a)		20			20					9			9
1918	25,940	759	479	27,178	0	27,178	12,118	452	12,570	13,453	303	470	14,226	75		75	16	4	20	(b)	18	12			12	248		9	257				
1919	57,697	1,368	1,833	60,898	61	60,959	23,176	611	23,787	32,893	714	1,833	35,440	219	43	262	71		71	(b)	24	68			68	1,246			1,246	55		6	61
DEATHS																																
1918	7	1	0	8	0	8	4	1	5	3			3																			
1919	4	0	0	4	0	4	3		3	1			1																			
DISCHARGES																																
1918	1	0	0	1	0	1	1		1																							
1919	1	0	0	1	0	1	1		1																							

TRENCH MOUTH[c]

Years	Total Army (enlisted men)						United States			Europe				Philippine Islands			Hawaii			China	Panama	Transports				Other countries				Native troops			
	White	Colored	Color not stated	Total American enlisted men	Total native troops	Total enlisted men	White	Colored	Total	White	Colored	Color not stated	Total	White	Colored	Total	White	Colored	Total	All white	All white	White	Colored	Color not stated	Total	White	Colored	Color not stated	Total	Filipinos	Porto Ricans	Hawaiians	Total
ADMISSIONS																																
1917	0	0	0	0	0	0																										
1918	26	0	2	28	0	28	1		1	25		2	27																			
1919	44	0	5	49	0	49	10		10	34		5	39																			
DAYS LOST																																
1917	0	0	0	0	0	0																										
1918	835	0	6	841	0	841	18		18	817		6	823																			
1919	1,148	0	15	1,163	0	1,163	367		367	709		15	724									72			72							
DISCHARGES																																
1919	2	0	0	2	0	2	2		2																							

[a] Included with transports.

[b] Included in Philippines.

[c] Deaths, none.

In 1917 there were 261 primary admissions for Vincent's disease among American enlisted men, 223 in the United States and 9 in Europe. The number greatly increased the following year, with a total of 1,762. Of these, 857 were among enlisted men stationed in the United States and 848 in Europe. This increase continued during 1919, when the primary admissions amounted to 4,159, with 1,770 in the United States and 2,272 in Europe. The Army in Europe was much smaller in 1919, yet the number of primary admissions markedly increased. Not only was the disease more prevalent in Europe, but the vast majority of cases reported from stations in the United States were among troops returning from Europe. It was of rare occurrence in the large military hospitals in the United States until patients were returned from Europe for further hospitalization and troops for demobilization. At the base hospital, Camp Grant, Ill., the disease was first noticed immediately upon arrival of the first consignment of patients from abroad, December, 1918.[9] Some 8,000 overseas patients were cleared through this base hospital, in addition to approximately 35,000 patients admitted from commands that had not been abroad. The overseas patients were received between December, 1918, and June, 1919. In addition to these troops, many thousands of overseas troops were sent direct to Camp Grant for demobilization. A chronic ulcerative condition of the gums and tonsils, especially the former, was noticed among the first arrivals and received active attention of the dental surgeons. It was first thought by the internist to be of syphilitic etiology and by the chief of the dental service to be a new disease. The patients spoke of their condition as "trench mouth" and some said it had been diagnosed as the "fourth venereal disease." Finally the internist and the dental surgeons agreed that the disease was Vincent's disease, described more particularly in foreign literature. From January, 1919, until this base hospital closed during the following summer, Vincent's disease was constantly present among overseas patients, but nothing in the archives of this camp or hospital indicates spread from one person to another.

The consensus of opinion among medical officers who served with troops at home before the war and with troops during the war not sent abroad is that Vincent's disease is a rare malady; however, it was quite a common affection among American troops serving in Europe. It is further recognized that the majority of cases did not seek admission to hospital; therefore, the number of admissions does not represent the occurrence. The statistics of an American base hospital at Coblentz, Germany, show Vincent's disease to have been very common and present in at least 20 per cent of cases admitted to the throat wards.[10] It is further shown that this disease was not the cause of admission to hospital in the majority of cases.

As shown in Table 80, Vincent's disease was reported among American enlisted men serving elsewhere than in the United States and Europe. In 1917 there were 29 primary admissions reported among such troops, 24 of which were in the Philippines, 2 in Hawaii, and 3 on transports. The same number of primary admissions was reported during the following year. Of these, 7 were reported in the Philippines, 3 in Hawaii, 2 in Panama, 3 on transports, and 14 in countries not specified. In 1919 the number increased three or four fold. The Philippines reported 15 primary admissions; Hawaii, 7; Panama, 3; transports, 4; and countries not specified, 88.

Although occurring among American troops serving in the Philippines and Hawaii, Vincent's disease was of little or no importance among the native troops. There were 6 primary admissions among the Philippine Scouts and 1 among the native Hawaiian troops during the period of the war.

The white American soldier was more commonly affected than the colored. There were 5,873 primary admissions among the former and 157 among the latter. In addition to these, 152 primary admissions were reported where color was not stated. It is a recognized fact that the American negro suffers less from tooth and gum affections than the white man; therefore, it is not surprising to find that the occurrence of Vincent's disease was no exception to the rule. Prevalence in Europe and in the United States, based upon the reported cases, was about evenly divided, not only in the total primary admissions, but also by race.

Vincent's disease was an appreciable cause of noneffectiveness among troops during the war. There were 92,690 days lost from duty by the 6,189 primary cases, with an average of 14.97 days per case. The average days lost was greater in Europe than at home, being 13.52 and 17, respectively. The number of days of hospitalization was greater for white than for colored troops. For the former the average was 14.60 and for the latter 13.43 days. White enlisted men admitted to hospital on account of Vincent's disease lost an average of 13.66 days in the United States and 16.33 in Europe. Colored troops did not show such great variation, being 13.33 in the former country and 14.52 in the latter. When viewed by years of occurrence, it is seen that the average time lost in 1917 was 9.73 days; 1918, 15.67; and in 1919, 14.81 days, for the total Army. With the exception of 1917, the duration of hospitalization was longer in Europe than in the United States. In this year it was 6.33 and 9.84, respectively. Conditions were reversed the following two years. In 1918 and 1919, respectively, the average was 16.77 and 15.87 in Europe and 14.66 and 13.51, respectively, at home.

ETIOLOGY

The whole story in the etiology of Vincent's disease has not been told; however, since the report of Plaut, and later, the contributions by Vincent, it is generally accepted that the *Bacillus fusiformis* and *Spirochæta vincenti* are intimately associated as causal factors. Yet these organisms are normal inhabitants of the mouth. Nichols [11] states that some strains appear to take on virulent characteristics producing ulceration and are capable of being spread to others. He asks: "How are the two organisms related to each other and to the disease?" "Are they primary or secondary causes? If primary, how can the epidemic be identified?" There is no adequate answer at present to these crucial questions. Fusiform bacilli, other than those of Vincent, have been found in the mouth, some quite indistinguishable, morphologically, from the Vincent bacillus.

According to Zinsser,[12] the fusiform bacilli described by Vincent, Plaut, Babes, and others are from 3 to 10 micra in length, and have a thickness at the center varying from 0.5 to 0.8 micron. From the center they taper gradually toward the ends, ending in blunt or sharp points. The length of these bacilli

may vary greatly within one and the same preparation. They are usually straight, sometimes slightly curved. They do not stain very easily with the weaker analine dyes, but are readily stained by Löffler's methylene-blue, carbol fuchsin, or better, by Giemsa's stain. Stained by Gram, they are usually decolorized, though in this respect the writers have found them to vary. Stained preparations show a characteristic inequality in the intensity of the stain, the bacilli being more deeply stained near the ends, and showing a banded or striped alternation of stained and unstained areas in the central body. The staining qualities in this respect are not unlike those of the diphtheria bacillus, and, according to Babes,[13] the dark areas are to be interpreted as metachromatic granules. The bacilli are not motile.

The spirilla found in Vincent's angina, according to Zinsser, are usually somewhat longer than the fusiform bacilli, and are made up of a variable number of undulations, shallow and irregular in their curvatures unlike the more regularly steep waves of *Spirochæta pallida*. They are stained with even more difficulty than the bacilli and usually appear less distinctly in the preparations. The stain, however, is taken without irregularity, showing none of the metachromatism observed in the bacilli.

The organisms conceded to give rise to Vincent's angina do not occur in the mouth alone, but are usually accompanied by such other organisms as the staphylococcus, the streptococcus, and, at times, the diphtheria bacillus. It has been said that the two organisms of Vincent exist in symbiosis. Whether they are primarily concerned in the cause of the disease, or are merely secondary invaders, has not been determined. Animal inoculation has not assisted in elucidating this factor; however, the consensus of opinion is that the organisms of Vincent play an important rôle in the cause of Vincent's disease, yet the postulates of Koch have not been established with respect to them.

Some workers, as noted, contend that Vincent's disease is not a separate and distinct entity and that the ulcerative type is usually syphilitic. These suppositions are based upon appearance of the ulceration, chronicity, and Wassermann reaction. Diagnosis can not be made on appearance alone, and the disease, in its uncomplicated form, is neither preceded nor followed by syphilitic manifestations. It yields to local treatment. There is ample evidence to support the statement that the Wassermann reaction is negative in Vincent's disease unless the disease is superimposed on a syphilitic infection.

Barnes[14] states that the most destructive and fatal forms of gangrenous necrosis in which these organisms are found occur in subjects with leucemia or one of the other of the essential blood diseases.

Bouty[3] remarks that abundant bacilli, mixed with cocci, are found in the pseudomembranous form of the disease, and that bacilli associated with Gram-negative, mobile, flagellated spirilla are found in the ulcerative form.

British observers regard Vincent's disease as being always preceded by gingivitis.[1] In an examination of 3,000 men, in military hospitals of England during 1918, who were admitted on account of wounds and diseases other than gingivitis, 359 cases, or 11.9 per cent, showed gingivitis, of which 354 were either subacute or chronic and 5 ulcerative.[1] Barker and Miller[15] regard Vincent's disease as being, in all probability, primarily a peridental gingivitis, and remark

that it is associated with characteristic gum lesions and capable of spreading to any part of the throat and mouth, possibly along the trachea and bronchi into the lungs. McKinstry[16] believes that gingivitis is always the primary focus from which the disease spreads to the tonsils, palate, etc. He examined 1,320 healthy soldiers and found the fuso-spirochetal organisms in 32; he also found 95 positives among 230 recruits. The relationship of Vincent's disease to peridental gingivitis is the subject of a report by Taylor and McKinstry.[17] They made systematic examination of the gums in 70 cases of Vincent's disease and in every case found the gums to be infected. In the great majority of cases there was a localized peridental or marginal gingivitis; and out of 150 cases of fuso-spirillary gingivitis found, the characteristic lesions of Vincent's disease were present in the tonsil or pharynx in 70.

The organisms of Vincent have been shown in the mouths of persons suffering from the disease and also in normal mouths. If we accept these organisms as exciting cause, carriers, both acute and chronic, exist. But, as pointed out by Nichols,[11] with our present knowledge there is no scientific basis for carrier work. The exact mode of spread and underlying factors that bring about outbreaks are not well understood, yet the literature contains accounts of not infrequent epidemics. An outbreak in the German Army, Sauberwald[7] reported, started in one ward of a central hospital and suddenly appeared in other wards. Barker and Miller[15] found that this disease may be very infectious, as shown by the occurrence of 200 cases among 800 prisoners of a German camp in two days.

Predisposing factors are of importance equal to or greater than the presence of Vincent's organisms. The former may be controlled; the latter can not be eradicated. Of first magnitude is faulty oral hygiene. The presence of dental caries, fermenting organic matter, faulty dentition, and neglect in oral hygiene lead to gingivitis, pyorrhea alveolaris, peridental infections, abscesses, etc. The resistance of the mucous membrane of the mouth and perhaps resistance of the entire body are lowered. The mouth becomes foul and in this condition the spirochete flourishes. Those who are in a physically run-down condition are very prone to develop the disease.

During the war, especially the early part, as mentioned at the outset, Vincent's disease was often spoken of as trench mouth, trench gums, etc. It is believed that nothing in trench service per se, other than the congregating of large numbers of persons and separating them from the necessary means of maintaining clean mouths, played any part in causing the disease.

The use of tobacco has been considered an important factor in increasing susceptibility. Barker and Miller [15] refer to the importance of undernourishment, and Sauberwald [7] considers it an important factor in the outbreak above referred to. Generally speaking, the disease is more common as age advances. British statistics [1] show that the age group under 25 years furnished the lowest percentage of cases—i. e., 6.7 per cent—and those over 35 the highest, namely, 19.2 per cent in one group and 33 per cent in another. No age, after dentition is established and before all teeth are lost, appears exempt. The part played by the vitamines as predisposing factors appears unsettled.

SYMPTOMS

After an unknown incubation period, the disease sets in slowly, as a rule, with the formation of a grayish, greenish, or yellowish diphtheroid membrane situated more commonly on the tonsil, but also occurring on the gums, uvula, pharynx; in fact, it may be found on the mucous membrane of the larynx, bronchi, or trachea, usually by extension. The common sites are the tonsil and gums. This membrane is adherent and leaves a red bleeding surface when removed. The breath is foul. Gingivitis and pyorrhea alveolaris are commonly associated with Vincent's disease. The lesions are usually unilateral, but not always so. The lymph glands that drain the infected area are invariably enlarged and usually painful; they do not suppurate. Swallowing is commonly painful. The constitutional symptoms, as a rule, are neither marked nor in proportion to the degree of pathological involvement seen in the mouth. It is not uncommon for the temperature to be normal; however, 99° to 100° F. is usual, and occasionally 102° or higher is seen. Headache, anorexia, malaise, slight pains in the joints, lassitude, and some depression in variable degree are common.

Ulceration usually follows the pseudomembrane formation. The ulcer has irregular, undetermined edges and a "punched out" appearance, and though it is usually confined to the soft parts, involvement of underlying bone has been reported. Pain is not a conspicuous symptom. When located on the tonsil the ulcer is usually unilateral and situated nearer the posterior pillar. Cases have been reported where the entire tonsil had been destroyed by the process. These lesions contain the organisms of Vincent; however, other forms of bacteria are present in the smears which may require consideration in diagnosis. Large areas of the mouth may be involved. Infection may extend over the mucous membrane of the entire mouth.

Vincent classified the disease into two types: (*a*) The superficial pseudomembranous, or diphtheroid type, in which a thin grayish-white film usually starts over one tonsil and gradually spreads to adjacent tissue. It is remarked that the membrane is easily removed, though not en mass, leaving a bleeding base and shallow ulcer. (*b*) The ulcerative and more common form in which there is deep tissue ulceration covered by a thick, creamy, yellow exudate easily removed, leaving a red, granular, bleeding base. Both forms show a tendency to be unilateral. Vincent's classification is generally accepted, yet there are workers who have reported differently. Campbell and Dyas [18] divide the disease into types as follows: Type I, tonsil cases; type II, ulcer of the lower jaw immediately behind the last molar tooth; type III, gingival cases; type IV, general infection of the buccal cavity. McKinstry [16] describes several types, namely, affections of the gums, affections of the tonsils (Vincent's angina), and affections of the mucous membrane of the buccal cavity. This author emphasizes the statement that the commonest form of the disease is an ulcerative peridental gingivitis especially common around the lower incisors, posterior lower molars, crowned teeth, and between irregular ones. Kiefer,[19] remarking on Vincent's classification into diphtheroid and ulceromembranous types, says that this is doubtful since we find vesicular, lacunar, membranous, and ulcerative forms either alone or in combination. Medical officers during the war accepted

the original classification and noted that the majority of cases were seen in ambulant persons during the ulcerative state.

Experience has proved that Vincent's disease is not confined to the mouth and that it is at times a more serious malady than formerly believed to be Multiple lesions occur on the mucous membrane in various parts of the body. A number of deaths have been reported. This will be discussed more fully under prognosis. Bowman [20] reported a case with several lesions in different parts of the body. The primary infection was probably in the mouth, the glans penis, and conjunctivæ later becoming infected, probably by the fingers. Campbell and Dyas [13] reported seven cases of bronchial infection with a clinical picture of a moderately severe bronchitis, copious expectoration, little elevation of temperature, and general depression; the sputum was loaded with Vincent's organisms. The infection was self-limited and lasted about three weeks. These authors reported four cases of balanitis of Vincent origin. There was a long edematous prepuce whereon a membrane formed and extended to the glans. Corbus [21] described ulcerative balanitis due to Vincent's infection as the "fourth disease." He expressed the opinion that this condition is often incorrectly diagnosed as chancroid; however, it can be differentiated by the presence of the *B. fusiformis* and spirillum of Vincent in the former and the Ducrey-Unna bacillus in the latter. A case was reported from the base hospital in Coblenz with ulceration of the meatus urethræ that showed the fusiform bacillus and spirillum. It yielded to local treatment and was diagnosed as Vincent's disease.

Recovery usually takes place in a week [22] and recurrences are not uncommon. According to Bouty,[3] recurrences may take place even three weeks after the first attack, in which case complications are more liable to occur. Recurrences were common among the American forces in Germany, yet there was nothing to indicate that these second attacks were different from the primary ones in severity. Among the approximately 25,000 patients that passed through the base hospital in Coblenz, there were two deaths attributed to Vincent's disease.[10] In one, the direct cause of death was suffocation following edema of the larynx; in the other, death was attributed to streptococcic septicemia complicating Vincent's disease. In both cases there was extensive ulceration and membranous formation about the tonsil, hard and soft palates. The larynx became involved in the former case. In the latter, a severe streptococcic throat infection developed, complicating the Vincent's disease. Abscess formation was suspected about the tonsils, but incisions revealed no pus. Before death the blood culture was positive for the streptococcus.

DIAGNOSIS

The diagnosis of uncomplicated Vincent's disease is not difficult. The comparatively slow onset, cervical lymph adenitis, foul breath, mild or absent constitutional symptoms, with unilateral lesions, constitute the usual clinical picture. A positive diagnosis can be made only by miscroscopic examination. Stained smears and dark field examination show the presence of *Bacillus fusiformis* and Vincent's spirochete.

The ulceromembranous form must be differentiated from diphtheria, for the pseudomembrane in Vincent's disease is not unlike a true diphtheritic membrane. The ulcerative form of Vincent's disease must be differentiated from syphilis,

It may be possible to make this differentiation on dark field examination, as the *Spirochæta pallida* is morphologically different from the Vincent's spirochete is easily differentiated by those familiar with the characteristics of these organisms. This applies more particularly to the primary lesion of syphilis when located in the mouth. In ulcerative tonsillitis, or ulcers of syphilitic origin located elsewhere in the mouth, the Wassermann reaction is of the greatest assistance, being positive in syphilis and negative in Vincent's disease. A history of specific infection and appearances of syphilis elsewhere in the body will support the diagnosis.

It must be remembered that Vincent's disease is at times superimposed upon both diphtheria and syphilis. It is also to be remembered that Vincent's disease may occur in a pure diphtheria carrier. All combinations of these conditions existed among American troops during the war.

Brumbaugh [23] reports as follows on the dark field study of five cases of pseudomembranous oral infection diagnosed clinically as Vincent's disease at the base hospital, Camp Dodge, Iowa:

Case 1.—White; age, 22 years. Soreness of the mouth dates from the extraction of a molar tooth one month ago; dysphagia, but no pain; smokes considerably, but teeth are sound and clean. The lesions consist of several grayish white patches on the right tonsil and a large patch of similar color involving the right side of the soft palate, extending to the gum of the upper jaw and the cheek, having a sharply defined margin and a narrow reddish zone of hyperemia around it. The base of the ulcer bleeds readily when the membrane is scraped off. The lymph nodes at the angle of the jaw on both sides are enlarged, especially on the right. The axillary and inguinal glands are moderately enlarged and easily palpable. A pigmented scar is found on the shaft of the penis. The patient claims it was caused by chancroid one year ago. His skin is clear of eruption. Wassermann test: Negative. Throat smear: Stained preparations showed the presence of the spirochetes and fusiform bacilli characteristic of Vincent's angina. Dark field examination of secretion from the lesions revealed the presence of enormous numbers of motile fusiform bacilli and coarse coiled spiral organisms, both forms being very active and darting across the microscopic field so rapidly that their morphology could be distinguished only when they are slowed up at clumps of cells or débris in the preparation. Diagnosis of ward surgeon: Vincent's angina. Dark field diagnosis: Vincent's angina.

Case 2.—White; age, 23 years. His sore throat is of three weeks' duration. Pharynx and palate are granular and red and scattered patches of grayish exudate are present on the postpharyngeal wall and right tonsil. The gum about the two posterior lower right molars is reddish, swollen, projecting above the teeth and covered with grayish membrane. The lymph nodes at the angle of the jaw are moderately enlarged; the inguinal and axillaries are also readily palpable. Patient denies veneral infection. There are no scars on the genitalia and the skin is clear. He smokes tobacco rather immoderately. The teeth are clean and free from caries. Wassermann test: Negative. Throat smear: Stained preparation shows the presence of Vincent's organisms. Dark field examination reveals very numerous coarse coiled spirochetes and a few fusiform bacilli, both forms very motile. Diagnosis of ward surgeon: Tonsillitis, acute, follicular. (2) Vincent's angina, right tonsil, moderately severe. Dark field diagnosis: Vincent's angina.

Case 3.—White; age, 23 years. His sore throat is of 10 months' duration. Lesions consist of a granular ulceration of the soft palate, having a reddish base, with scattered irregular areas of grayish pseudomembrane. He smokes moderately and his teeth are good and clean. Throat culture: Showed *Bacillus diphtheriæ* absent; a few hemolytic streptococci present. Throat smear: Stained preparation three months previously showed Vincent's angina organisms. Two weeks ago none was present. Wassermann tests, made, respectively, two months ago and three months ago and at the present time, are all negative. Dark field examination revealed rapidly motile fusiform bacilli and coarse coiled spirochetes. Diagnosis

of ward surgeon: Vincent's angina, severe, involving the fauces and soft palate. Dark field diagnosis: Vincent's angina.

Case 4.—White; age, 31 years. His sore throat began six weeks ago. Both tonsils and soft palate are covered with a grayish white membrane, marked off with a narrow hyperemic zone. The lymphatics at the angle of the jaw and the postcervical chains are enlarged. The inguinal lymphatics are slightly enlarged. The patient is obese, weighing 205 pounds. He has several scars on the penis, which he attributes to soft chancres six weeks ago. His skin is clear. He complains of rheumatism of the ankles. He smokes very rarely. His teeth are clean and free from caries. Throat culture showed hemolytic streptococci. Throat smear: Stained preparation showed presence of Vincent's angina organisms, Gram-positive diplococci and diptheroid bacilli. Wassermann test, made recently, was negative. Dark field examination reveals the presence of a very few typical *Treponema pallida* and a few Vincent's organisms. Diagnosis of ward surgeon: Vincent's angina. Dark field diagnosis: Secondary syphilis.

Case 5.—White; age, 22 years. His sore throat is of six months' duration. He smokes considerably. His teeth are slightly tobacco stained and he had two carious molars. Otherwise his teeth are in good condition. The lesions consist of grayish white patches on the soft and hard palate, the lateral and inferior surface of the tongue, and on the lower lip. They have smooth serpiginous margins and a very narrow zone of hyperemia about the palate lesion, but none around the tongue and lip lesions. The membrane is tightly adherent and does not bleed readily if the surface is rubbed. He denies venereal infection and the skin of the body is free from eruptions. The glands at the angle of the jaw are markedly enlarged. The axillaries and inguinals are also moderately enlarged. The genitalia are free from scars. Throat culture one week previously showed bacillus diphtheriæ absent. Throat smear: Stained preparation showed Vincent's angina organisms present. Wassermann test one week previously was mildly positive. Dark field examination revealed a few typical *Treponema pallida.* Diagnosis of ward surgeon: Acute catarrhal pharyngitis and Vincent's angina. Dark field diagnosis: Secondary syphilis.

Blood changes in Vincent's disease are of but slight diagnostic importance. There is but little change in the number of white cells. A leucocytosis of over 10,000 is rare. Deglos,[6] reporting 21 cases observed in his hospital, remarks that the white counts were about 10,000 and the red cells usually were reduced to 3,000,000. Anemia was not a conspicuous sign among the American cases, as shown by review of the clinical records. All cases were not clear-cut in their symptomatology, as shown by the following case abstracted from the records of the base hospital at Camp Grant, Ill. Although several diagnoses were suggested by various consultants, the final diagnosis was Vincent's angina.

Corporal V———, Company A, 333d Machine Gun Battalion. Admitted May 2, 1918. Died August 16, 1918. The chief complaints on admission were: Pains in the stomach, chest, back, and head, vertigo, and slight cough, for the past two weeks. There was no expectoration. Examination of the clinical record shows a continuous temperature of the septic type throughout the course of the disease. The general condition on admission was good. The throat was congested and lymph glands negative. The genitourinary system was negative for pathological findings. The patient denied all venereal diseases. Otherwise the physical examination was negative. Based upon the physical examination and laboratory reports, the following diagnoses were made: (1) Fermentation, intestinal; (2) Vincent's angina.

On May 4 the right tonsil was red, swollen, and covered with an exudate. The tongue was red and coated; the breath was foul; the heart showed no abnormal findings; the spleen was palpable; a few coarse moist râles were heard over the base of both lungs. On May 12 diagnosis was made of a dento-alveolar abscess about the upper left first molar tooth. This was incised and drained. The wound received regular daily treatment. Smears showed Vincent's organisms. Arsenobenzol, 0.49 gram, was given intravenously. The glands of the neck were enlarged and tender. The intestinal fermentation was recorded as cured.

Necrosis of the upper left maxillary bone was later recorded, extending upward from the left second bicuspid tooth. The condition of the patient did not improve and on July 17 was such that transfusion of blood was thought advisable. A 250 c. c. citrated transfusion was administered. It was repeated on July 26 with 500 c. c. and again on August 5 with 350 c. c.

On July 20 there was a large sloughing area about the left upper maxilla. The patient was pale and felt weak. The tonsil was covered with an exudate and the urine showed albumin. Frequent consultations among the chiefs of services were held. The X ray showed osteomyelitis.

On July 15 a portion of the alveolar process showed sequestration. Blood examination this date showed 792,000 red cells, 13,000 white cells, and 30 per cent hemoglobin. The differential count showed 90 per cent large mononuclear, 5 per cent small mononuclear, and 5 per cent polymorphonuclear cells.

Condition generally improved following each transfusion, but improvement of short duration, usually lasting about three days. The red cell count remained about 1,000,000 hemoglobin per cent low; local condition showed a tendency to improve; the general condition did not improve. The patient became weaker, temperature continued elevated, and he died August 16, 1918.

The patient received five blood transfusions and two doses of arsenobenzol, in addition to various local applications. Several operations were performed to remove dead bone. The smears were negative for diphtheria bacilli. The Wassermann reaction was negative; also Widal reaction, and blood otherwise negative. Syphilis was excluded. The glands of the neck did not suppurate. Lymphosarcoma was suggested and X-ray treatments were given. Leukemia and pernicious anemia were also suggested, but not concurred in.

On July 11, the chief of laboratory reported as follows:

Red cells, 1,040,000; white cells, 8,400; hemoglobin, 35 per cent; large mononuclears, 58 per cent; small mononuclears, 31 per cent; polymorphonuclears, 11 per cent. A further study of the blood pictures of this patient shows that he has an index of 1.25; that he has many large, deeply stained red cells such as are commonly seen in advanced anemia of the splastic type. His blood cells have recently been as high as 24,000 which is decidedly against this as a diagnosis. The white cells show a very remarkable condition. There are, at this time, almost no polynuclear cells to be seen. There are, however, cells evidently of bone marrow origin in the blood which can be classed as myelocytes; and there are others less mature. I take the latter to be myeloblasts and premyeloblasts. There is also a decided relative increase in the number of lymphocytes. The total white count is low. This, however, is not an impossible finding in leukemia. On the whole, the blood picture might be interpreted as a myelogenous leukemia. Smears which I took from the mouth this morning show: (1) Nothing suggestive of Vincent's angina; (2) a diplococcus which in some places is seen in chains of from 4 to 8 organisms and which may be a streptococcus.

This patient was in hospital 107 days. The report of necropsy and histological reports are as follows:

AUTOPSY NO. 81

On this the 16th day of August, 1918, I held in the morgue of the base hospital a post-mortem examination upon the body of Corp. V———, Company A, 333d Machine Gun Battalion, who died in ward 32, August 16, 1918, with the clinical diagnosis of Vincent's angina. * * *

The left side of the face is swollen more than the right, and there is a definite swelling of the tissue about the superior maxilla downward to the angle of the jaw. There is no recent blood in the nostrils or the external auditory canals. On the left side from a point directly behind the upper canine tooth and extending backward to the last molar, which is loose, there is a necrosis into the antrum of Highmore through an opening fully 1 cm. in diameter. There is a bluish discoloration and a loosening of the mucous membrane along the gum margin of the teeth practically everywhere, but mostly those teeth which are posterior and below. The first lower left molar is loose, the second is absent, and the third is also loose. The mucous membrane is very pale. The neck is fairly long and there is an enlargement of the cervical lymph glands particularly on the left side.

* * * Upon eviscerating the chest and abdomen in the usual way there are found no injuries on the inside of the thorax other than such as might have been produced by tearing of the adhesions between the parietal and visceral pleura. The lining of the aorta is very pale, quite smooth, and roughened only by scattered areas of subintimal fatty infiltration. The lymph glands along the aorta everywhere are increased in size, and for the most part are rather dark brown or cyanotic in color; they are also fairly firm. The lymph glands at the bifurcation of the trachea are small and on the surfaces made by sectioning there are firm

gray pale white nodules 1 mm. in size. The lining of the esophagus is very pale, otherwise it is normal save for a slight epitheliosis of its lining. The lymph glands at the bifurcation of the trachea are moderately increased in size and are fairly large. On the left side there is a mass of glandular tissue very much increased in size; the section surfaces of this gland being very firm and pale. This mass of glandular tissue is rough, 3 by 4 by 2 cm. and extending out onto the pleural surface just above the region of the pericardium, and on the outer surface of the pericardium there are translucent white nodules which lie close to the mass of glandular tissue just described. There are also gray areas on the pleural surfaces of the left lung, just above the point where the left bronchus enters this organ.

The lining of the trachea and main bronchi is very pale. On the outer surface of the right lung there are numerous subpleural petechial hemorrhages. The posterior portion of this lung is somewhat boggy, but contains air throughout. The anterior margin of the left lung is adherent to the pericardial sac, and on the surface made by sectioning this tissue this organ is very pale. The anterior margin of the left lung is firmly adherent to the pericardial sac. In the region of the thymic body there are lymph glands, some of them very red but containing on the surfaces made by sectioning pale white nodules from 1 to 2 mm. in diameter. In one of the lymph glands there is a small caseous calcified spot 1 mm. in diameter. * * *

* * * On the right side the lymph glands of the cervical region are large and form a mass along the course of the deep vessels of the neck. The thyroid gland is very pale, but otherwise is quite normal. On the left side the cervical lymph glands are also enlarged. The enlargement extends upward. There are no changes in the esophagus, or pharynx. The larynx is very pale, but there is no disease of this organ. The section surfaces of the lymph glands removed from the left cervical region are large and pale white; they are very firm. On the surface made by sectioning the septa of the glands extend down into their substance dividing the firm pale areas, already mentioned, into areas of tissue completely or partially separated from each other. In such lymph glands where the enlargement has not completely destroyed the gland there are white areas from 1 to 2 mm. in diameter. Both sera maxillary glands, on both sides, are incapsulated, but otherwise appear quite normal.

No further examination of the body was made.

ANATOMIC DIAGNOSIS

1. Extensive chronic suppurative necrosis of the alveolar process of the left superior maxillary bone.
2. Chronic suppurative sinusitis of the left antrum of Highmore.
3. Numerous absent teeth.
4. Chronic generalized suppurative gingivitis and pyorrhea alveolaris.
5. Chronic inflammatory edema of the left side of the face.
6. Marked chronic nonsuppurative adenitis of the right and left cervical and of the parabronchial lymph glands.
7. Marked emaciation.
8. Marked generalized anemia.
9. Multiple petechial hemorrhages and small suggillations of many tissues of the body.
10. Cloudy swelling and acute fatty changes of the myocardium and parenchymatous organs.
11. Marked hyperplasia of the spleen, biliary, mesenteric, and abdominal aortic lymph glands.
12. Chronic nodular caseous and calcified tuberculosis of the parabronchial lymph glands.
13. Left chronic nodular fibrous tuberculosis pleuritis.
14. Serous atrophy of the peritoneal adipose tissue.
15. Slight left hydrothorax.
16. Slight hydropericardium.
17. Chronic diffuse nephritis—large white kidney.
18. Slight subintimal fatty infiltration of the aorta.
19. Persistent musculomembranous Eustachian valve.
20. Fibrous patches in the tricuspid leaflets.
21. Fenestration of the cusps of the aortic semilunar valve.
22. Bilateral fibrous pleuritis.
23. Left intersigmoid fossa.
24. Fibrous adhesive perisplenitis.
25. Multiple accessory spleens.
26. Numerous venæ and hypodermic needle puncture wounds of both arms.
27. Old circumcision scar of the foreskin of the penis.
28. Slight decubital necrosis over the sacrum and left posterior superior iliac spine.

HISTOLOGICAL REPORT

L——— V———. *Autopsy No. 81.*

(A) Lymph gland: There is a marked increase in the mononuclear cells of this lymph gland. These cells are relatively large with a fairly abundant margin of cytoplasm and a relatively clear vesicular and slightly mottled nucleus. The lymph gland for the most part consists of these cells which resemble in many respects endothelial cells as they are found in lymph glandular tissue. So profound are the changes in this lymph gland that there is very little lymphoid cells as such, the tissue consisting essentially of these large mononuclear cells packed very closely. Even the capsule of the lymph gland in places has been invaded by these cells.

(B) Lymph gland: Around the lymph gland there is a certain amount of edematous adipose tissue. It too contains many large mononuclear cells. These cells have penetrated into the adipose tissue surrounding the lymph gland.

(C) Lymph gland: The description as given in A and B holds true for C, with this exception, that the density in the arrangement of the large mononuclear is greater and in the centers of the more densely arranged portions there are areas of about one-fifth millimeter and smaller where the cells have undergone necrosis. The nuclei of these cells are pycnotic, fragmented, or entirely missing, the cytoplasm of the cells being pinkly stained. These areas of necrosis are fairly abundant. The lymphoid cells in this gland too are arranged in nodules, relatively small.

(D) Lymph gland: The same as A and B, without areas of necrosis.

(E) Lymph gland: Contains areas of necrosis, the striking features of which is that the outline of the cells in the destroyed tissue is still present.

(F) Lymph gland: Similar to A and B, with very little necrosis.

(G) Lymph gland: Similar to A and B, with small hemorrhages in one spot.

Liver: The uniformity of the liver structure under the microscope is broken by collections of mononuclear cells in numbers from about a half dozen to others in areas fully 1 millimeter in maximum dimensions. These areas are usually perilobularly arranged along the portal canals or occasionally appearing toward the center of the lobules. The latter condition is the exception rather than the rule. These mononuclear cells are as given in A, B, C of the lymph glands described, namely, cells with circular nuclei and a moderate amount of cytoplasm. The sinusoids of the liver for the most part are widely distended, around the peripheral portions of the lobules, they being less wide than toward the centers. The liver chords diminish in width toward the center of the lobules where the cytoplasm of the cells is practically gone. Where present the cytoplasm is vacuated. These retrogressive liver changes in the liver chords extend fully two-thirds to three-fourths of the distance from the center to the periphery of the lobules.

Testicle: There is a marked atrophy of the testicular epithelium, with absolutely no or very little spermatogenisis. The tubules are very small and between the tubules there is an extensive infiltration of the tissue with mononuclear cells such as have been described in several places above.

Spleen: In the spleen, too, there is a profound proliferation of endothelial cells. Many of the endothelial cells are pigmented a light brown and contain either injected red cells or circular, irregular masses of a brown amorphous substance. Some of these are light brown on yellow granules.

Adrenal: The cells of the adrenal cortex are markedly vacuolated. This is true almost throughout the entire substance of the organ.

Accessory spleen: There is a decided hyperplasia of endothelial cells of this organ similar to the description given for the spleen proper. There is a small area of necrosis about one-half millimeter in diameter in this section.

Kidney: There is a moderate interstitial edema in this organ, and there are scattered areas of endothelial mononuclear cell infiltration in size from a few cells to others one-fourth of a millimeter in diameter. These are commonly found around the glomerulæ and along the vessels. The tubular epithelium of the convoluted tubules is fairly low, and in the lumina of these tubules there are pinkly stained granules. There are pink granules in the capsule spaces of the glomerular spaces also.

PROGNOSIS

The majority of cases terminate in complete recovery. The average duration among American soldiers during the World War was 14.97 days.

Among 6,189 primary admissions for Vincent's disease in the Army during the war, the records show 12 deaths. No deaths were reported during 1917. In 1918, there were 8 deaths, 7 among white troops and 1 among colored. During the following year there were 4 deaths among white enlisted men. Eight of the deaths occurred in the United States and 4 in Europe. All were reported among cases primarily admitted to hospital on account of Vincent's disease, and in probably all instances, the deaths were due to complications.

As a basis for discharge from the service on surgeon's certificate of disability, Vincent's disease was of minor importance. The records of the Surgeon General's Office show four enlisted men discharged from the service on this account, all white. In 1918, there was one such case in the United States. In 1919, there were three cases, also in the United States. Since Vincent's disease is self-limited, beyond doubt the soldiers were discharged for some associated condition or complication; however, the records do not permit of analysis to determine this matter in detail.

PREVENTIVE MEASURES

No specific preventive measures were known before the war and none developed during that period. It has been established that the disease is an infection; however, the method of transmission is unknown. The organisms of Vincent are constantly present where Vincent's disease exists, but are also normal inhabitants of the mouth. The important factor seems to be in the prevention of lowered local and constitutional resistance. The best results are accomplished by proper oral hygiene. Accepting the British point of view, if the gums and teeth are kept clean, there can be no marginal gingivitis, and if no marginal gingivitis develops, pyorrhea and Vincent's disease do not develop. Since the organisms are contained in discharges from the lesion, which is commonly located in the mouth, the proper care of drinking cups and eating utensils is of importance.

In some camps during the war attempts were made to quarantine contacts merely on account of the presence of a few Vincent organisms in the throat. In view of our incomplete knowledge of the transmission of Vincent's disease from one individual to another, and in view of the presence of the causative organisms in the mouths of many normal individuals, quarantine is not considered practicable.

TREATMENT

Specific and empirical treatment have been advocated by contributors to the literature of the therapeutics of Vincent's disease. In the specific treatment arsenic is used both locally and intravenously, while in the empirical treatment such medicaments as silver salts, methylene blue in alcohol, liquor potassii arsenitis, and salicylic acid are recommended.

In 1910, Ehrlich [24] called attention to the value of salvarsan in the treatment of Vincent's disease. On account of the specific action of this drug upon spirochetes, especially the *Spirochæta pallida*, many clinicians have used it in the treatment of Vincent's disease, especially in its severer forms. The drug, how-

ever, is expensive and acts best only when given intravenously. Partly on this account and partly because the vast majority of cases recover under simple local treatment and the correction of faulty oral hygiene, it has not been used as a routine.

It has been said that a good dentist is the best therapeutic measure. Filthy mouths must be cleaned up, and gingivitis and pyorrhea alveolaris must be adequately treated, if satisfactory improvement is to be expected. Local application of drugs, curettement, and intravenous therapy are merely adjuncts.

Intravenous administration of salvarsan or neosalvarsan was used in the Army in protracted cases; however, only rarely was it necessary. Generally speaking, patients suffering from Vincent's disease were admitted to wards set aside for patients suffering from inflammation of the throat. No special attempt was made to quarantine them, and if detected in other wards where they happened to be for a concurrent disease, they were allowed to remain in these wards as long as the primary cause of admission was the more important from the treatment standpoint. The records of several hospitals show special care taken in the handling of eating utensils. There is nothing in the available records to indicate that any patient contracted Vincent's disease while in hospital.

Mercury in any form is contraindicated for these patients on account of its physiological action on gum tissue. It is best to refrain from the use of tobacco while under treatment. The use of the toothbrush must be encouraged; Vincent's disease is more common in those who are lax in this respect. In some hospitals, patients suffering from this disease were lined up after meals, each with his toothbrush, and marched to the toilet or other place where they could clean their teeth, the cleaning being supervised by one in authority. Further, they were taken to the dental surgeon at regular intervals. In this manner proper oral hygiene was soon established and maintained. This is the most important phase of the treatment.

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CHAPTER XVIII

THE MALARIAL FEVERS[a]

COMPARISON OF MALARIAL RATES FOR THE WORLD WAR WITH PREVIOUS AND SUBSEQUENT MALARIAL RATES, UNITED STATES ARMY

Prior to the World War, malaria in the United States Army had been controlled with a high degree of efficiency, as shown in Table 81. Satisfactory as had been the reduction in morbidity and mortality from malarial fevers, most apparent in our troops serving in the Philippine Islands, Panama, and Porto Rico, the results obtained by our medical officers and sanitarians in the prophylaxis of these fevers during the World War were much better, despite the fact that many of our great camps were located in regions where endemic malaria was severe.

TABLE 81.—*Malarial fevers. Admissions and deaths, enlisted men, United States Army, 1911 to 1920. Ratios per 1,000*

Year	White enlisted				Colored enlisted		Porto Rican	Filipino
	United States	Philippine Islands	Hawaiian Islands	Panama	United States	Philippine Islands	Porto Rico	Philippine Islands
ADMISSIONS								
1911	15.47	75.56	6.95	53.92	0.68		131.03	242.12
1912	14.65	186.35	6.22	120.31	4.42	45.89	52.72	241.91
1913	8.82	126.27	9.05	145.55	7.67	38.65	31.99	193.49
1914	11.05	48.60	1.44	208.96		30.35	12.73	201.80
1915	12.86	68.43	2.24	87.57	6.56	21.63	[1] 8.34	80.11
1916	22.43	60.74	2.40	66.50	10.56	87.83	[2] 69.63	43.38
1917	7.50	50.24	3.54	109.23	5.85	81.68	26.65	56.63
1918	3.91	22.11		75.67	4.48	44.09	57.28	46.47
1919	3.58	14.68		82.18	1.22	45.46	45.41	41.12
1920	7.54	8.37	.80	55.13	2.06	51.36	24.79	26.32
DEATHS								
1911		.08						.57
1912		.36						.55
1913		.21						.57
1914								
1915	.03							
1916	.02							
1917	.01	.11		.25		.66		
1918	.01			.24	.04		.24	.18
1919	.01	.26		.20	.04		.48	.12
1920				.23				

[1] Includes National Guard officers.
[2] Includes officers.

There was a marked decrease in the admission rates for malaria for white enlisted men during the period 1911–1920, in the United States, the ratio for 1916 being 22.43 per 1,000; in 1917, 7.50 per 1,000; in 1918, 3.91 per 1,000; and in 1919, 3.58 per 1,000, the latter rate having been obtained despite the fact that during 1917 and 1918 hundreds of thousands of untrained and susceptible recruits were mobilized in camps situated in regions of malaria endemicity. The admission rates for malarial fevers in the Philippine Islands, Panama, and Porto Rico (all classes) were also reduced, although to a lesser extent, the lower reduction in these countries being due undoubtedly to continuing greater

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

exposure to infection, in spite of the rigid sanitary measures taken to prevent infection.

The rise in the United States malarial rate in 1920 was probably due to the necessity of curtailing the antimosquito work in camps during the latter part of 1919 and in 1920, owing to the lack of funds.

ADMISSION[b] AND DEATH RATES DURING THE WORLD WAR

In the period from April 1, 1917, to December 31, 1919, inclusive, the total number of admissions for malaria was 15,555, this number including officers and enlisted men of both American and native troops. There were 36 deaths recorded as due to malaria and 28 discharges for disability. The total loss of time recorded as caused by the malarial infections (primary cause of admission) was 194,529 days.

The malarial fevers were not included among the 30 leading diseases for our Army, as a whole, either for admissions, deaths, discharges for disability, or time lost. However, in Panama they ranked second for admissions, third for deaths, and second for time lost, for American enlisted men. Among Filipino troops, the malarial fevers ranked third for admissions, eleventh for deaths, and fourth for time lost, while for Porto Ricans (Porto Rico and Panama) these fevers ranked eighth for admissions, third for deaths, and seventh for time lost.

The greatest number of cases of malaria occurred in the United States, but the highest admission rate was in American troops serving in Panama. The native Porto Ricans furnished the next highest admission rate and the highest death rate.

The admissions, deaths, and discharges for disability for malaria, with ratios per 1,000, are given in Table 82.

TABLE 82.—*Malarial fevers. Admissions, deaths, and discharges for disability, officers, and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers, ratios per 1,000, per cent of total diseases, and relative standings*

Rank and country	Admissions				Deaths				Discharges for disability			
	Absolute numbers	Ratios per 1,000 strength	Per cent of total diseases	Relative standing among diseases[1]	Absolute numbers	Ratios per 1,000 strength	Per cent of total diseases	Relative standing among diseases	Absolute numbers	Ratios per 1,000 strength	Per cent of total diseases	Relative standing among diseases
Officers:												
United States	328	2.64	0.45	-------	1	0.01	0.12	-------	-------	-------	-------	—
Europe	60	.81	.16	-------	-------	-------	-------	-------	-------	-------	-------	-------
Total (including other countries)	437	2.12	.38	-------	1	.00	.07	-------	-------	-------	-------	-------
American enlisted men:												
United States	10,182	4.82	.43	-------	23	.01	.07	-------	25	0.01	0.02	—
Europe	890	.56	.10	-------	2	.00	.01	-------	-------	-------	-------	-------
Philippine Islands	639	29.79	3.27	10	2	.09	2.74	12	-------	-------	-------	-------
Hawaiian Islands	24	1.23	.20	-------	-------	-------	-------	-------	-------	-------	-------	—
Panama	1,739	88.34	11.30	2	3	.15	9.38	3	-------	-------	-------	—
Total including other countries)	13,674	3.52	.41	-------	30	.01	.05	-------	26	.01	.02	-------
Native troops:												
Filipino	843	45.38	6.93	3	2	.11	1.71	11	2	.11	.56	0.12
Porto Rican[2]	600	50.72	3.87	8	3	.25	2.42	3	-------	-------	-------	-------
Hawaiian	1	.18	.30	-------	-------	-------	-------	-------	-------	-------	-------	-------
Army total	15,555	3.77	.44	-------	36	.01	.06	-------	28	.01	.02	-------

[1] Thirty leading diseases; a *dash* indicates a standing below 30.
[2] Served in Panama as well as Porto Rico.

[b] Only primary admissions are taken into account until Table 88 is considered.

DISTRIBUTION IN THE ARMY

Of the total 15,555 primary admissions for malaria in the United States Army, no less than 10,510 were in the troops serving in the United States. Only 950 admissions are recorded as occurring in our troops serving in Europe, while 1,482 admissions were in the Philippine Islands, 1,739 in Panama (American troops), 600 in Porto Rico and Panama (Porto Ricans), and 24 in the Department of Hawaii. In addition to the above, 249 admissions for malaria were among officers and enlisted men serving in other countries.

Of the 36 deaths reported as due to malaria, 24 occurred in the United States, 2 in Europe, 4 in the Philippine Islands, 3 in the Canal Zone (American), and 3 in Porto Rico and Panama (Porto Ricans).

The rate of admissions per 1,000 for officers serving in the United States was 2.64 and for enlisted men, 4.82; in Europe, for officers, 0.81, and for enlisted men, 0.56; in Panama, for white enlisted men the ratio per 1,000 was 88.34; in the Philippine Islands 29.79, and in the Hawaiian Islands, 1.23. For native troops the ratio per 1,000 was highest for Porto Ricans, i. e., 50.72 and lowest, for Hawaiians, i. e., 0.18 per 1,000. The ratio per 1,000 for native Filipino troops was 45.38.

The low rate for troops serving in the Hawaiian Department is explained by the fact that the malarial fevers are not present in the Hawaiian Islands except as imported cases, there being no well-authenticated instance of a case of malaria originating in the Hawaiian Territory. All malaria infections occurring in our troops in these islands were, therefore, relapses of infections acquired elsewhere.

The malarial fevers caused 11.3 per cent of the sick admission rate in American troops serving in Panama, 6.93 per cent of that in the Philippine Islands, and 3.87 per cent of the admission rate in Porto Rican troops. In the United States malaria caused less than 0.45 per cent of the total admission rate for disease in the Army, while in Europe these infections caused less than 0.15 per cent of our total admission rate for disease.

It is evident that in countries in which the chances for infection were greatest, as in Panama, the Philippine Islands, and Porto Rica, the incidence was greatest, but even in such regions the rates, on the whole, were low when compared with the pre-war rates.

RACIAL DISTRIBUTION

The admission rate per 1,000 for officers was 2.12; for American enlisted men, 3.52; and for native troops, 40.09. There was, however, a great difference in geographical situation, native troops all serving in highly malarious countries.

The absence of immunity to malaria in native troops appears to be established by a comparison of the ratio per 1,000 for American and Filipino troops, both serving in the Philippine Islands, where the ratio per 1,000 for American enlisted men was only 29.79 as compared with a ratio of 45.38 for enlisted Filipinos.

However, caution should be used in drawing the conclusion from these data that native troops possess no immunity to the malarial infections. In the absence

of information regarding relative exposure to infection between the two groups and whether the native troops had been exposed previously to malaria, it is impossible to state definitely that the native troops were more susceptible to malarial infection than white troops; but it is fair to assume, in view of these figures, that such immunity as the native troops possessed in the Philippine Islands was of little worth in protecting them from the infection and could not be depended upon as of any practical value in military operations. The experience of our Army in this respect is similar to that of other armies and demonstrates that there is no such thing as a true racial immunity to the malarial infections.

TABLE 83.—*Malarial fevers. Admissions, deaths, discharges for disability, and days lost, by race, enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

	Absolute numbers				Ratios per 1,000			
	Admissions	Deaths	Discharges for disability	Days lost	Admissions	Deaths	Discharges for disability	Non-effectiveness
White	12,690	24	24	155,683	3.53	0.01	0.01	0.12
Colored	861	5	2	15,299	3.00	.02	.01	.15
Filipino	843	2	2	9,120	45.38	.11	.11	1.35
Hawaiian	1			5	.18			.00
Porto Rican	600	3		7,092	50.72	.25		1.64
Color not stated	123	1		1,926				
Total Army (enlisted men)	15,118	35	28	189,123	3.85	.01	.01	.13

In comparing American and native troops, the ratio per 1,000 of admissions for malaria shown in Table 83 was greatest for Porto Ricans and smallest for colored soldiers. For the former it was 50.72 per 1,000 and for the latter only 3 per 1,000. The ratio per thousand for Filipino troops was 45.38; for Hawaiian soldiers 0.18, and for white soldiers 3.53. While this table illustrates what actually happened so far as such statistics can show, it should not be interpreted as proving any racial susceptibility to malaria, for both Porto Rican and Filipino troops were serving in malarial countries, while the vast majority of our white troops were not exposed to malaria, and the troops composed of native Hawaiians in Hawaii were absolutely unexposed, malaria not being present in the Hawaiian Islands owing to the absence of anopheline mosquitoes.

DISTRIBUTION IN WHITE TROOPS IN THE UNITED STATES, PANAMA, PHILIPPINE ISLANDS, AND HAWAIIAN ISLANDS

An inspection of Table 84 demonstrates that the admission and death rates from malaria for white enlisted men for the World War period was highest in Panama and lowest in Europe. In Panama the ratio per 1,000 for malaria was 88.34; in the Philippine Islands, 25.48; in the United States, 4.89; in the Hawaiian Islands 1.48, and in Europe, 0.47.

The malarial fevers were far more prevalent in white enlisted men serving in Panama than in those serving in the Philippine Islands, the ratio per 1,000 for the former being 88.34 as compared with 25.48 for the latter. Thus, the

ratio per 1,000 for Panama was over three times that for the Philippine Islands. Without accurate knowledge of the local conditions affecting the exposure of the men in the two countries, it would be unwise to attempt to draw any conclusions as to the cause of the much higher ratio in Panama. However, it is evident that during the period of the World War our white enlisted men serving in Panama were three times as apt to contract malaria as those serving in the Philippines, as shown by the actual ratio per 1,000 of malarial infections. The cases of malaria recorded for the American Expeditionary Forces doubtless were relapses of infection acquired in the United States as no evidence was obtainable that original infections were acquired in France.

TABLE 84.—*Malarial fevers. Admissions, deaths, discharges for disability, and days lost, by countries of occurrence, white enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

Country	Absolute numbers				Ratios per 1,000			
	Admissions	Deaths	Discharges for disability	Days lost	Admissions	Deaths	Discharges for disability	Non-effective
United States	9,617	18	23	115,181	4.89	0.01	0.01	0.16
Europe	697	1	----	15,930	.47	.00	----	.03
Philippine Islands	433	2	----	5,982	25.48	.12	----	.96
Hawaiian Islands	24	----	----	282	1.48	----	----	.05
Panama	1,739	3	----	16,867	88.34	.15	----	2.35
Total Army (white enlisted men) [1]	12,690	24	24	155,683	3.53	.01	.01	.12

[1] Includes figures for "Transports."

DISTRIBUTION IN WHITE AND COLORED ENLISTED MEN, BY CAMPS, IN THE UNITED STATES

From Table 85 it may be seen that the greatest number of admissions for malaria was at Camp Beauregard, La., (726); the second greatest number at Camp Pike, Ark., (703); the third (469) at Camp Jackson, S. C.; the fourth (356) at Camp Travis, Tex.; the fifth (344) at Camp Shelby, Miss.; the sixth (233) at Camp Johnston, Fla.; the seventh (223) at Camp Wheeler, Ga.; the eighth (206) at Camp Sevier, S. C.; the ninth (203) at Camp Gordon, Ga.; the tenth (163) at Camp Logan, Tex.; the eleventh (161) at Camp Taylor, Ky.; the twelfth (122) at Camp Eustis, Va.; the thirteenth (115) at Camp McClellan, Ala.; the fourteenth (113) at Camp Bowie, Tex.; while a smaller number occurred at the other camps in the United States. Only one admission for malaria was reported at Camp Forrest, Ga., and one at Camp Greenleaf, Chickamauga Park, Ga.

While the camps mentioned stand in the above order as regards the actual number of admissions for malaria in the troops serving within them, a study of the ratios per 1,000 admissions in these camps results in a very different relative standing. Considered in this way, the camps mentioned stand in the following order: (1) Camp Beauregard, La.; (2) Camp Shelby, Miss.; (3) Camp Pike, Ark.; (4) Camp Jackson, S. C.; (5) Camp Eustis, Va.;[c] (6) Camp Wheeler,

[c] Occupied only a part of war period.

Ga.; (7) Camp Johnston, Fla.; (8) Camp Travis, Tex.; (9) Camp McClellan, Ala.; (10) Camp Sevier, S. C.; (11) Camp Taylor, Ky.; (12) Camp Gordon, Ga.; (13) Camp Humphreys, Va.; and (14) Camp Logan, Tex. It should not be deduced from these statistics that the malarial infections all actually originated in these camps, as they do not distinguish between infections contracted in the camps and those due to relapse of previously acquired malaria.

TABLE 85.—*Malarial fevers. Large camps, United States. Admissions, deaths, and discharges for disability, white and colored enlisted men, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

Camps	Admissions				Deaths				Discharges for disability			
	White		Colored		White		Colored		White		Colored	
	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000
Beauregard, La	694	34.35	32	75.83								
Bowie, Tex	112	4.44	1	1.05								
Cody, N. Mex	34	1.50							1	0.04		
Custer, Mich	4	.11	3	2.21								
Devens, Mass	21	.46	6	2.70					1	.02		
Dix, N. J	56	1.25	7	1.45								
Dodge, Iowa	28	.84	4	.69								
Doniphan, Okla	82	3.07										
Eustis, Va	121	19.13	1	2.19								
Forrest, Ga	1	.11										
Tremont, Calif	43	2.79										
Funston, Kans	75	1.50	20	3.24	1	0.02						
Gordon, Ga	185	4.86	18	2.64					1	.03		
Grant, Ill	8	.19	14	2.02								
Greene, N. C	33	1.26	4	1.13					1	.04		
Greenleaf, Ga	1	.08										
Hancock, Ga	84	2.31	3	1.88	2	.05						
Humphreys, Va	40	4.10	9	2.92								
Jackson, S. C	414	11.22	55	10.72								
Johnston, Fla	115	5.79	18	7.46					1	.05		
Kearney, Calif	28	1.10										
Lee, Va	45	.88	2	.30					2	.04		
Lewis, Wash	55	1.16										
Logan, Tex	163	6.11			1	.04						
MacArthur, Tex	56	2.30	3	3.15	1	.04			1	.04		
McClellan, Ala	97	3.66	18	8.45								
Meade, Md	47	1.12	14	1.74					1	.02		
Mills, N. Y	83	3.62	2	1.59								
Pike, Ark	639	15.64	64	7.34	2	.05			1	.02	1	0.11
Sevier, S. C	199	7.60	7	4.36								
Shelby, Miss	317	11.01	27	16.34								
Sheridan, Ala	79	3.08	5	5.65					2	.08		
Sherman, Ohio	15	.41	8	1.38								
Syracuse, N. Y	4	1.19										
Taylor, Ky	140	3.29	21	4.79	2	.05	1	0.23				
Travis, Tex	327	8.72	29	4.41								
Upton, N. Y	22	.55	8	1.71								
Wadsworth, S. C	43	1.43	2	1.79								
Wheeler, Ga	213	8.91	10	5.51			2	1.10				
Others			3	8.85								

DISTRIBUTION BY STATES

It does not follow that every man inducted or enlisted in a particular State was a native of that State; nevertheless, it is true that the majority were and that practically all had been residing in the State from which inducted or enlisted long enough to contract malaria infection if it were present. That this supposition is correct is borne out by the data shown in Table 86, which agree with the well-known distribution of the malarial infections in the United States.

TABLE 86.—*Malarial fevers. Admissions, deaths, discharges for disability, by State of induction, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919*

State	White enlisted men											
	United States			Europe			Total United States and Europe					
	Absolute numbers			Absolute numbers			Absolute numbers			Ratios per 1,000		
	Admissions	Deaths	Discharges	Admissions	Deaths	Discharges	Admissions	Deaths	Discharges	Admissions	Deaths	Discharges
Alabama	815	2	1	47			862	2	1	19.57	0.05	0.02
Alaska	1						1			.50		
Arizona	9						9			.89		
Arkansas	622		1	23			645		1	15.37		.02
California	116			6			122			1.17		
Colorado	15			2			17			.52		
Connecticut	32			4			36			.78		
Delaware	6						6			1.03		
District of Columbia	10			3			13			1.16		
Florida	204			7			211			11.21		
Georgia	570	1	3	29			599	1	3	12.88	.02	.06
Idaho	9						9			.52		
Illinois	555	2		28			583	2		2.59	.01	
Indiana	220			12			232			2.54		
Iowa	110			15			125			1.38		
Kansas	93	1	7				100	1		1.74	.02	
Kentucky	326			21			347			5.75		
Louisiana	480			42			522			15.57		
Maine	17	1		1			18	1		.79	.04	
Maryland	65			2			67			1.80		
Massachusetts	103			11	1		114	1		.95	.01	
Michigan	96		1	15			111		1	.91		.01
Minnesota	70			9			79			.86		
Mississippi	1,279	1	2	57			1,336	1	2	49.04	.04	.07
Missouri	360			27			387			3.47		
Montana	4			1			5			.15		
Nebraska	41			8			49			1.13		
Nevada	1						1			.21		
New Hampshire	9						9			.66		
New Jersey	116	1		7			123	1		1.29	.01	
New Mexico	21	1	1	1		1	22	1	1	1.02	.08	.08
New York	319		1	42			361		1	1.87		
North Carolina	241	1		13			254	1		5.28	.02	
North Dakota	10						10			.41		
Ohio	157		1	26			183		1	1.01		.01
Oklahoma	153		1	9			162		1	2.30		.01
Oregon	20			2			22			.79		
Pennsylvania	223		1	19			242		1	.92		
Rhode Island	25			4			29			1.69		
South Carolina	161			8			169			6.82		
South Dakota	20			1			21			.75		
Tennessee	473	2		32			505	2		9.33	.04	
Texas	626	2	3	32			658	2	3	5.32	.02	.02
Utah	1			2			3			.19		
Vermont	8			1			9			.91		
Virginia	134		1	5			139		1	3.08		.02
Washington	13			1			14			.34		
West Virginia	50			4			54			1.15		
Wisconsin	70		1	8			78		1	.85		.01
Wyoming												
Others or not stated	538	3	5	103			641	3	5			
Total	9,617	18	23	697	1	1	10,314	19	23	3.29	.01	.01

TABLE 86—*Malarial fevers. Admissions, deaths, discharges for disability by State of induction, white and colored enlisted men, United States Army, United States and Europe, April 1, 1917, to December 31, 1919*—Continued

Colored enlisted men

State	United States			Europe			Total United States and Europe					
	Absolute numbers			Absolute numbers			Absolute numbers			Ratios per 1,000		
	Admissions	Deaths	Discharges	Admissions	Deaths	Discharges	Admissions	Deaths	Discharges	Admissions	Deaths	Discharges
Alabama	54	1		8			62	1		2.60	0.04	
Arkansas	38			4			42			2.55		
District of Columbia	1						1			.23		
Florida	23			1			24			2.00		
Georgia	75	2		9			84	2		2.71	.06	
Illinois	2			1			3			.32		
Indiana	1						1			.23		
Iowa	1						1			.82		
Kansas				1			1			.49		
Kentucky	10		1	3			13		1	1.19		0.09
Louisiana	73		1	8			81		1	3.09		.04
Maryland	5			2			7			.77		
Massachusetts	1						1			.84		
Minnesota				1			1			2.05		
Mississippi	70			21			91			4.16		
Missouri	6						6			.70		
Nebraska	2						2			3.25		
North Carolina	28			4			32			1.67		
Ohio	4						4			.53		
Oklahoma	2			1			3			.55		
Pennsylvania	3						3			.21		
South Carolina	62			4			66			2.84		
Tennessee	27	1		2			29	1		1.75	.06	
Texas	57	1					57	1		1.87	.03	
Virginia	9			3			12			.56		
Wyoming	2						2			22.22		
Others or not stated	9			2			11					
Total	565	5	2	75			640	5	2	1.85	.01	.01

As regards the absolute number of admissions for malaria, a study of Table 86 shows that Mississippi led the States in the number of admissions (1,427), and this is also true as regards the ratio per 1,000. Arranged in order of relative total admissions for malaria the States showing the greatest number stand in the following order: (1) Mississippi, 1,427; (2) Alabama, 924; (3) Texas, 715; (4) Arkansas, 687; (5) Georgia, 683; (6) Louisiana, 603; (7) Illinois, 586; (8) Tennessee, 534; (9) Missouri, 393; and (10) New York, 361.

Though the various States of the Union stand in the above order as regards the absolute number of admissions for malaria occurring in the enlisted men inducted or enlisted from them, the true incidence of the malarial infections can be determined only by a consideration of the ratio per 1,000 of inducted or enlisted men from each State. A study of the table shows that the States stand in the following order as regards the actual percentage or ratio per 1,000 for malaria, the figures applying only to white enlisted men, the small number of infections in colored troops being negligible for the present purpose: (1) Mississippi, 49.04; (2) Alabama, 19.57; (3) Louisiana, 15.57; (4) Arkansas, 15.37; (5) Georgia, 12.88; (6) Florida, 11.21; (7) Tennessee, 9.33; (8) South Carolina, 6.82; (9) Kentucky, 5.75; (10) Texas, 5.32.

The relative prevalence of malaria in enlisted and inducted men, as shown in the above list of 10 States, agrees almost perfectly with what is known regarding the relative prevalence of malarial infections in the civil population of the United States. It is noted that inducted and enlisted men from the States of Mississippi, Alabama, Louisiana, and Arkansas showed the highest ratios per 1,000 for malaria, and it is well known that malaria is more prevalent in these States than in any other States of the Union. It will also be noted that the ratio per 1,000 for men from Mississippi is three times that for men from any other State, and this also agrees with other observations regarding the relative frequency of malaria in the Southern States of the Union. The ratios per 1,000 shown for the other States in the above list agree well with what was known regarding the distribution of malaria in the United States before the World War, and it can not be said therefore that our records have added anything new to our knowledge as to the distribution of malarial infections in this country. While this is true, the data are of value in demonstrating what may be expected as regards the incidence of malaria in men enlisted or inducted from the various States in the Union. It is certain from Table 85 that a very considerable proportion of the malaria occurring in our camps was not due to local infections but to relapses of infections contracted before arrival in the camps. These relapses occurred in men coming from States well known to be heavily infected with this disease. Therefore it is evident that a considerable amount of malaria, in the form of relapses, must be expected in troops recruited in the States of Mississippi, Alabama, Louisiana, Arkansas, and other Southern States, while practically no malaria will occur in the form of relapses in troops recruited in New Hampshire, Wyoming, Arizona, Nevada, and other States of the northern and western groups. It must also be remembered that most of the relapse cases are "carriers" of malarial infection. This subject, so important from the standpoint of prophylaxis, will be considered below.

SEASONAL PREVALENCE

Malarial fevers were present in our troops throughout the year, but were most prevalent during the summer and autumn months (Table 87). In 1917 and 1918 the greatest prevalence of malaria was in May, June, July, August, and September, the highest ratio per 1,000 occurring in 1917 in June (14.31), and in 1918 in July (8.36). In 1919, the highest ratio per 1,000 occurred in November (15.64), probably due to the fact that the majority of relapses occurred at this time.

Due to climatic conditions in the States whose men showed the greatest number of admissions for malaria, it may be stated that most of the cases admitted during the months of November, December, January, February, March, and April were relapses of infections contracted during the other months of the year. It is also undoubtedly true that a certain proportion of the cases admitted during May, June, July, August, and September were "relapse" cases; admitting these facts, however, the table demonstrates beyond question that there was a great increase in malaria in our troops, commencing in May and reaching its acme in 1917 in June; in July in 1918; and in November in 1919. The higher prevalence of the malarial infections in November, 1919, is probably

partially due to the fact that prior to that time funds for the prosecution of antimosquito work had been greatly curtailed coincident with demobilization of the Army.

As a whole, Table 87 demonstrates that malarial infections in our troops were most prevalent during the months of June, July, August, and September, and this agrees perfectly with what was previously known regarding the seasonal prevalence of these infections in the parts of the United States in which our various camps were situated.

TABLE 87.—*Malarial fevers. Admissions by months, white and colored enlisted men, United States, April 1, 1917, to December 31, 1919. Absolute numbers and ratios per 1,000*

	White		Colored		Total	
	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000	Absolute numbers	Ratios per 1,000
1917						
April	151	9.86	1	2.46	152	9.67
May	222	10.85	1	2.06	223	10.65
June	375	14.55			375	14.31
July	414	10.83	1	1.80	415	10.95
August	428	9.13	6	8.45	434	9.10
September	921	14.23	9	11.48	930	14.20
October	858	9.97	15	8.26	873	9.94
November	349	3.95	32	9.79	381	4.15
December	156	1.66	9	2.93	165	1.70
1918						
January	118	1.29	8	1.89	126	1.32
February	117	1.28	4	.96	121	1.27
March	233	2.48	7	1.53	240	2.43
April	287	2.95	12	2.44	299	2.92
May	567	5.68	39	5.34	606	5.66
June	813	7.48	47	6.32	860	7.41
July	919	8.30	93	8.92	1,012	8.36
August	761	7.11	124	8.83	885	7.31
September	592	5.38	81	5.90	673	5.43
October	178	1.59	20	1.31	198	1.56
November	107	1.02	13	1.04	120	1.02
December	48	.61	10	1.15	58	.67
1919						
January	31	.55	4	.70	35	.57
February	33	.84	3	.55	36	.80
March	36	1.06	3	.81	39	1.04
April	53	1.87	2	.81	55	1.79
May	44	1.81	7	4.04	51	1.96
June	44	2.14	2	1.29	46	2.08
July	102	5.69	2	1.20	104	5.31
August	134	10.26	3	2.00	137	9.41
September	117	9.40	4	4.24	121	9.04
October	153	13.13	1	1.32	154	12.40
November	182	16.49	2	2.73	184	15.64
December	74	6.56			74	6.15
Total	9,617	4.89	565	3.88	10,182	4.82

MORTALITY

In the period between April 1, 1917, and December 31, 1919, 36 cases of malaria were reported as having died. These figures include all deaths from this cause (primary admission) in the entire Army, and it is believed that never before in the history of the world has so small a number of deaths from the malarial infections been recorded in any army in time of war.

PREVENTIVE MEASURES

The principal prophylactic method employed in the United States Army, and the one that gave the best results, was the prevention of the breeding of

mosquitoes.[d] The efforts of the medical officers of the Army in this direction were ably seconded by those of the officers of the Sanitary Corps and, in the extra-cantonment area, by those of the United States Public Health Service. An immense amount of time, labor, and money was expended in ditching, dredging, draining, and filling in, but the results obtained well repaid the effort and the funds expended, as shown by the low malaria rates in our training camps which were situated in infected localities.

In certain camps mosquito control was never complete, and other prophylactic measures were employed. Thus, at Camp Beauregard, La., where mosquito control was not satisfactory, it was found that the proper treatment of "carriers" and of cases contributed greatly to the control of the disease.[1]

RELATIVE EFFICIENCY OF PROPHYLACTIC MEASURES

The relative efficiency of the various methods of prophylaxis employed for the prevention of malaria has always been a subject of controversy. No data of value in the settling of this question are available in our records of the World War, as only two methods of prophylaxis were extensively employed in the Army; i. e., the prevention of mosquito breeding and screening. Our excellent results were due then almost entirely to the prevention of the breeding of the mosquitoes transmitting malaria in this country, plus screening. By reason of the magnitude of our antimosquito operations and their success, the experience of our Army probably furnishes the most striking example of the efficiency of antimosquito prophylaxis of malaria on record, an experiment so gigantic and so successful that it should end for all time any doubt as to the value of this form of prophylaxis in the prevention of malarial infection.

PRESENT STATUS OF PROPHYLACTIC MEASURES

As stated, the measures directed toward the prevention of the breeding of mosquitoes, plus screening, proved to be the most efficient in the control of malarial infections, but it should be remembered that our experience with the use of other methods was very limited, too much so to be of any real weight in the evaluation of the various methods generally employed. Screening and the treatment of "carriers" of malaria resulted in almost absolute protection at Ebert Field,[2] and had it been possible to apply these methods on as great a scale as the antimosquito methods were applied, it would be possible for a definite statement to be made regarding their relative value.

The following extracts from a report on the prophylaxis of malaria at Ebert Field, Ark., are of great interest as showing the value of quinine treatment of "carriers" and screening in the prophylaxis of these infections:

> The control of malaria at Ebert Field, Ark., represented an unusually difficult problem due to the extensive area, the high rate of malaria among natives, and particularly the problem of the rice fields which extended for many miles around the camp. It can truly be said that malaria was controlled in this zone, but that mosquitoes were not under control.
>
> The total number of cases of malaria reported from Ebert Field was 33. On these no cases were contracted in camp. The results on malaria control are indicated as follows:
>
> Control of mosquito production being humanly impossible so long as the rice fields were within flight distance of any and all parts of the area, it is interesting to compare the mortality

[d] See Vol. VI, Sanitation, Chap. X V.

and the history incidence of malaria in 1917 with the case reports, mortality, and September check index of 1918. In 1917 there occurred 4 deaths from malaria in the control area as against none in 1918. The history incidence index, 29 per cent, or expressed in the number of cases, 522, the only available record for 1917, when compared with the actual development of only one case in 1918, is conclusive proof of the efficiency of the control.

Since, in spite of the attempt to control production, *A. quadrimaculatus*, recognized as an efficient transmitter of malaria, was present in large numbers about the residences of the community, this diminution of malaria can be ascribed only to screening and the sterilization of the human "carriers"—the latter being probably the main factor.

* * * * * * *

The use of 10 grains of quinine sulphate by mouth for sterilization of the blood of malaria carriers is evidently sufficient for one malaria season if used actively over a period of 30 days.

British experience in Macedonia showed [3] that the best results in the prophylaxis of malaria were obtained when antimosquito measures and prophylactic quinine were combined, owing to local conditions which made antimosquito measures impossible. So far as the prevention of breeding places was concerned, Wenyon states[4] protection from the bites of mosquitoes was the most efficient prophylactic measure; he found that it was impossible to get rid of the mosquitoes and that the following were the most effective methods of prophylaxis under the existing conditions:

Evacuation of infected individuals.—The evacuation of infected individuals—i. e., those that showed by their history that they had a persistent infection—reduced the number of cases by removing the most heavily infected and also removed the "carriers" of the infection, thus preventing the infection of mosquitoes. The results of this measure alone he estimates as reducing the admissions by from 60 to 70 per cent. Over 25,000 men were thus evacuated, and he believes it no exaggeration to state that had these men remained they would have caused at least from fifty to sixty thousand additional admissions to hospital from malaria.

Quinine prophylaxis.—In his experience this method was disappointing, due to poor application. The dosage varied greatly in different commands and was generally insufficient, and no proper methods were adopted to see that the men actually took the drug distributed to them.

Mosquito nets.—Of all the methods tried, Wenyon regards the mosquito net as by far the most efficient in preventing infection. Head nets and gloves are also valuable.

When troops are engaged actively in campaign in a malarial region the main effort should be to protect the men from the bites of mosquitoes; the mosquito net, properly used, will accomplish this.

No data accumulated during the World War have changed our views regarding the relative value of the methods of malaria prophylaxis. The prevention of the breeding of the transmitting mosquitoes and protection from their bites are still the most efficient methods of prophylaxis, while prophylactic quinine, the segregation and proper treatment of "carriers," and the proper treatment of initial malarial infections are all considered valuable methods which should be combined with antimosquito measures. Especially important in malaria prophylaxis is the detection and treatment of "carriers" and the treatment of initial infections in order that the "carrier" state may be prevented.

ETIOLOGY

Despite the considerable amount of research work connected with the etiology of malaria that was accomplished by our medical officers and sanitarians during the period of the World War, no new facts of fundamental importance were discovered regarding the etiology of these infections.

THE SPECIES OF MALARIA PLASMODIA

Our experience with malaria during the World War was confirmatory of the existence of at least three species of the malaria plasmodia; i. e., *Plasmodium vivax*, the benign tertian plasmodium; *Plasmodium malariæ*, the quartan plasmodium; and *Plasmodium falciparum*, the estivoautumnal or malignant tertian plasmodium. There was a tendency among some observers in the British and French Armies to urge the unity of all malaria plasmodia, basing their arguments upon the apparent merging of one type of malarial infection into another, with a corresponding change in the morphology of the plasmodia observed in the blood of the patients. However, there is nothing in the published observations of any of the adherents of this theory that would indicate that mixed infections with more than one species of plasmodium could be eliminated, and at the present time it may be stated that no observations made during or since the World War have shaken, in the least, the evidence upon which is based the generally accepted belief in the plurality of species among the malaria plasmodia.

As regards the existence of more than one species of estivoautumnal plasmodium, little that is new was added to our knowledge as a result of the war.

In March, 1921, some new data were published by the writer regarding the species of the estivoautumnal plasmodia secured from the study of material from malarial patients in some of our camps.[5] These data were confirmatory of the existence of more than one species of this plasmodium and of the previous conclusions of the same writer that the estivoautumnal plasmodium should be divided into two types, one the species known as *Plasmodium falciparum* and the other, a subspecies, which this writer, in 1909, called *Plasmodium falciparum quotidianum*.[6] The evidence that these two forms exist rests upon distinct differences in morphology, in the length of the life cycle in man, and in the clinical picture of the infections which are produced by them. The morphological differences are as constant and distinctive as those between *Plasmodium vivax* and *Plasmodium malariæ*, while the striking difference in the temperature curve still further serves to differentiate them.

SPECIES OF ANOPHELES CONCERNED IN THE TRANSMISSION OF MALARIA IN CAMPS IN THE UNITED STATES

Early in the war the Surgeon General directed that collections be made of the prevailing mosquitoes in the training camps in the United States, and these collections were forwarded to the entomologist of the Army Medical Museum for diagnosis and preservation.[7] These collections were not carefully made in many instances, so that it is impossible to state what species of anopheline

mosquitoes were most prevalent in certain of our camps, but the following list gives the anopheline mosquitoes common to certain camps in which malaria was most prevalent:

Camp Beauregard, La	Anopheles quadrimaculatus.
	Anopheles punctipennis.
	Anopheles crucians.
Camp Dix, N. J	Anopheles punctipennis.
	Anopheles quadrimaculatus.
	Anopheles crucians.
	Anopheles walkeri.
Camp Eustis, Va	Anopheles quadrimaculatus.
	Anopheles crucians.
	Anopheles punctipennis.
	Anopheles barberi.
Camp Gordon, Ga	Anopheles punctipennis.
Camp Greene, N. C	Anopheles punctipennis.
Camp Jackson, S. C	Anopheles crucians.
	Anopheles punctipennis.
Camp Logan, Tex	Anopheles quadrimaculatus.
Camp McClellan, Ala	Anopheles punctipennis.
Camp Pike, Ark	Anopheles quadrimaculatus.
	Anopheles punctipennis.
Camp Shelby, Miss	Anopheles quadrimaculatus.
	Anopheles punctipennis.
	Anopheles crucians.
Camp Travis, Tex	Anopheles pseudopunctipennis.
Camp Wheeler, Ga	Anopheles quadrimaculatus.
	Anopheles punctipennis.
	Anopheles crucians.

Of these mosquitoes, *Anopheles punctipennis* is the least active as a carrier of malaria, and where it is noted as occurring alone it is probable that other more active species also occurred but were not included in the collections. *Anopheles quadrimaculatus* is the most active transmitter of malaria of the anophelines reported, with *Anopheles crucians* second in importance in this respect. *Anopheles walkeri* and *Anopheles barberi* have not been recorded as hosts of the malaria plasmodia.

THE LENGTH OF FLIGHT OF ANOPHELINE MOSQUITOES

The question of the length of flight of anopheline mosquitoes has always attracted much attention because of the importance of an accurate knowledge of this subject in prophylaxis. Craig,[8] in 1906, was the first to call attention to the fact that anopheline mosquitoes will fly over 2 miles in order to obtain a feeding of blood, although at that time it was generally believed by entomologists that anophelines did not fly for a greater distance than half a mile. It was not until the observations upon the Isthmus of Panama regarding the long-distance flight of anophelines that these findings were confirmed. During the World War some interesting and valuable observations along this line were conducted at Ebert Field, Ark.[2] The experiments consisted in catching and staining anopheline mosquitoes, liberating them at various distances from the camp, and then recatching as many as possible. During the time covered by the experiments there were only light air currents, so that the distances covered by the mosquitoes could not be explained by their being carried by winds. More than 5,000 mosquitoes were experimented with, and recatching was done at 37 different stations. It was found that the distances covered by the flight of anophelines varied all the way from one-quarter of a mile to 2½ miles, the

greatest number being caught at distances of from one-half to 1¼ miles. The conclusion was that in this locality a flight distance of at least 1 mile could be expected, but the range of *Anopheles quadrimaculatus*, the most common mosquito caught, could be as much as 2½ miles.

The observations detailed above amply confirm those made in 1906,[8] which were received at that time with incredulity by entomologists and sanitarians, and render it evident that little dependence can be placed upon prophylactic methods based upon the supposed short-flight distance of anophelines.

THE "CARRIER"

The importance of the "carrier"—i. e., the human being apparently well but whose blood contains the malarial gametocytes—was demonstrated again and some work was done, especially at Ebert Field, showing the importance of discovering and treating "carriers" in the prophylaxis of malaria. It was demonstrated also that "carriers" may be freed from their infection by persistent quinine treatment.

SYMPTOMATOLOGY

Nothing new was added to our knowledge of the symptomatology of malarial infections by observations made during the World War.

ASSOCIATION WITH OTHER DISEASES

The association of malaria with other diseases is shown in Table 88. A study of this table indicates that it possesses little scientific value as proving that any of the diseases in which malaria was secondary predispose to the latter infections to any great extent or that the malarial infections are more often associated with any one particular disease in any event. The number of cases is too small to base any important conclusions upon them, and the table is chiefly of interest as demonstrating that malaria actually was associated with the conditions mentioned.

TABLE 88.—*Malarial fever, secondary to other diseases. Enlisted men, United States and Europe, April 1, 1917, to December 31, 1919. Absolute numbers, ratios per 1,000, and percentage rates*

Primary diseases	Absolute numbers of secondary malarial fevers		Case rates (secondary)	Death rates (secondary)	Fatality rates (secondary
	Cases	Deaths			
					Per cent
Measles	47		0. 50		
Influenza (epidemic)	366	11	. 50	0. 01	3. 01
Meningitis, cerebrospinal	5	3	1. 08	. 65	60. 00
Mumps	72		. 33		
Typhoid vaccination	41		1. 20		
Tuberculosis of lungs	24	1	. 77	. 03	4. 17
Acute miliary tuberculosis	2	2	8. 40	8. 40	100. 00
Syphilis (all)	22		. 35		
Gonococcus infection	80		. 33		
Tonsillitis, acute	40		. 24		
Pharyngitis, acute catarrhal	21		. 43		
Bronchitis	172		. 73		
Pneumonia:					
Broncho	20	2	. 65	. 06	10. 00
Lobar	62	7	1. 44	. 16	11. 29
Intestines, other diseases of	21		. 35		
All others	380	8			2. 11
Total malarial fevers (secondary)	1, 375	34			2. 47
Total malarial fevers (primary)	11, 072	25	2. 99	. 01	. 23

PATHOLOGY

There were no new contributions to our knowledge of the pathology of malarial infection by our medical officers during the period of the World War.

DIAGNOSIS

During the war the diagnosis of malaria was based, in the vast majority of cases, upon the results of microscopic examinations of the blood of the infected individual. This is the first time in the history of our Army in war that the diagnosis of the malarial infections was made by an examination of the blood, for in our previous wars, with the exception of the Spanish-American War, such a method of diagnosis was not feasible, as the malaria plasmodia had not been discovered. In the Spanish-American War, as a matter of fact, the diagnosis of malaria was very largely based upon clinical symptoms, with the result that our statistics concerning the actual occurrence of malaria during that war are very inaccurate. During the Philippine insurrection the use of the microscope in the diagnosis of malaria became more general, but owing to lack of facilities and trained observers it did not become a general practice there except in our larger hospitals. However, for several years prior to the World War the diagnosis of malaria in our Army had been based entirely upon the results of blood examinations, and this wise practice was continued during the war. Every home camp was furnished with a splendidly equipped laboratory and specially trained officers and men, so that it was always possible to diagnose malaria by the examination of the blood. Conditions in this respect were equally favorable abroad.

No new method of diagnosis of malarial infections was evolved during the war by our medical or sanitary officers.

TREATMENT

In our Army, as well as in those of other nations, quinine continued to be the drug par excellence in the treatment of malarial infections, and no new substitute for quinine had been discovered. There was some difference of opinion as to the best method of administering this drug, but in our Army it was generally given by the mouth, with excellent results. In cases exhibiting pernicious symptoms the drug was administered intravenously.

In the British Army in Macedonia many medical officers favored the intramusculur use of quinine, but this method was rarely used by our medical officers. It is very questionable if the intramuscular injection of quinine should be adopted in preference to intravenous administration and our medical officers found that the administration of the drug by the mouth answered all purposes in the vast majority of the malarial infections that they encountered.

Some pessimistic papers were written during the war period by medical officers of the British Army as to the value of quinine in the treatment of malaria. The opinion is expressed that this spirit of doubt regarding the efficiency of quinine as a specific is entirely due to the results that have followed its administration in a faulty manner or to individuals who did not absorb the drug from the stomach when administered by the mouth. The opinion is also expressed that quinine properly administered and continued for a sufficient

period of time, will cure any case of malarial infection, provided the patient can take the drug; the experience of the British in treating invalided soldiers for malaria and returning them to duty is proof of this assertion.

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CHAPTER XIX

INTESTINAL PARASITES[a]

The greater number of the different kinds of animal intestinal parasites are of little or no military significance; they may have slight if any apparent effect upon either the health or efficiency of their hosts; they may be so restricted in occurrence as to be of little quantitative importance in the total volume of disease and physical deficiency of the troops. However, in the cases of seemingly healthy carriers of intestinal parasites, the military significance of the diseases which they cause rises in proportion to the facility with which they are spread from the carrier to uninfected men under conditions of camp and of field service. Though the sanitary conditions under military administration in this country are such as to preclude much if any spread of these parasitic infections, under the disturbed and changing circumstances surrounding active campaigning, carriers of intestinal parasites assume an importance proportional to the severity of the disease the parasites produce and the ease and rapidity with which the infection spreads. Viewed in these lights, one disease produced by an intestinal parasite rises to the level where it demands the cure of soldiers suffering from the disease and the elimination of carriers by treatment and cure. This is ankylostomiasis.

Whereas the life of the individual bacillus of typhoid or of dysentery is brief and the rate of multiplication of the individuals very rapid, the life of animal intestinal parasites, even of the Protozoa, is somewhat longer, and their rate of multiplication less rapid. Massive infections, quickly produced, are therefore less predominant among animal parasites than with the bacteria. This is much the more striking in the case of ankylostomiasis. The life of the hookworm is about 7 years in the case of the male and 10 in the female worm. The infection is lasting, the disease chronic, and the clinical symptoms may arise from a relatively small number of individual parasites. These facts of life history make the carrier element in the case of animal parasites one of grave importance in the epidemiology of the disease, tend to diversify the clinical pictures which the disease presents and to obscure the presence of the infection. For this reason the military surgeon may be misled as to the existence of these infections among troops and as to their extent unless he has the assistance of the clinical examination of the feces to determine the carriers.

ANKYLOSTOMIASIS

Ankylostomiasis is of considerable military significance because of the fact that it is in itself a disease which, in severe and chronic cases, may entirely disable the soldier. Also, in light infections it tends to increase the chronicity

[a] The data in this chapter are based, in the main, on the following articles: (1) Rapid Method for Detection of Ova of Intestinal Parasites in Human Stools, by Maj. Charles A. Kofoid, S. C., and Maj. Marshall A. Barber, S. C. *Journal of the American Medical Association*, Chicago, 1918, lxxi, No. 19, 1557. (2) The Geographical Distribution of Hookworm Infection in the United States, Detected in Army Recruits, by Charles A. Kofoid. *The American Journal of Tropical Medicine*, Baltimore, 1922, ii, No. 5, 389. (3) Report on parasites in overseas and home service troops of the U. S. Army, made by Maj. Charles A. Kofoid, S. C., Second Lieut. Sidney I. Kornhauser, S. C., and Second Lieut. J. T. Plate, S. C. On file, Historical Division, S. G. O.

and severity of other diseases, and to lower the intellectual and physical efficiency of the soldier. Since infection by this parasite may occur directly through the skin on contact with soil or water fouled by the feces of infected men, and since the worm, in the larval stage, may live in the soil for a year after deposition of the eggs in the feces of man, surviving freezing and even brief partial drying up, the spread of the infection among troops in trench warfare becomes distinctly possible, and the consequences of such extension of the infection a matter of serious consequences to the efficiency and health of the troops. The treatment and cure of both disease and carrier cases of hookworm infection is then a matter of military importance sufficient to justify prompt measures to detect the presence of the parasite and to cure all cases detected.

The enlisting and drafting of men for the Army from the known area of hookworm infection and their segregation in certain camps somewhat according to their geographical distribution laid the basis for a mass comparison of men from these regions with those from territory in which this infection was not prevalent. In some instances, as at Camp Logan, Tex., and Camp Wadsworth, S. C., men from the North were in cantonments in the neighborhood of others filled with men from the surrounding territory. They were thus under the same general environmental conditions as the men assembled in adjacent camps from the hookworm area.

A general opinion soon prevailed that the incidence of disease was relatively greater among men from the hookworm area than among the men from outside that region, an opinion since verified statistically by the studies of Vaughan and Palmer, and later supplemented by an intensive comparative study of the incidence of morbidity and mortality among men with hookworm and those in whom it was not detected at Camp Bowie, Tex., by Kofoid and Tucker.

In view of the prevalent opinion, the Surgeon General, on February 23, 1918, directed all surgeons to take all practicable measures for the early detection of ankylostomiasis, and for the adequate treatment of the infected before the men became exposed to the general infections commonly found in large camps. These instructions initiated the hookworm surveys which were made throughout the southern camps, the results of which are the basis of this chapter. Furthermore, as a result of investigations, which were carried on in the Southern Department, and which indicated some infection by the hookworm among northern men who had a year or more of service in the hookworm region and among southern men inducted from Northern States, supplemental instructions were promulgated by the Surgeon General on August 17, 1918. These supplementary instructions were as follows:

> All recruits and recently inducted men from the following States or other political divisions should be examined for hookworm as soon as possible after their arrival in your camp: Maryland, Virginia, District of Columbia, West Virginia, Kentucky, Missouri, Oklahoma, Texas, and all States lying to the south of them, and also Porto Rico, Cuba, Mexico, Hawaii, the Philippine Islands, and other tropical countries. Troops coming from other States, who have been serving for six months or more in the hookworm region, should also be examined and, when necessary, be treated for the disease. In addition, all patients admitted to hospital should be examined for intestinal parasites as rapidly as men can be trained for the work.

It was the aim to secure data, through the returns from the hookworm surveys made in accordance with the instructions referred to above, in the Army, which would make it possible to map the distribution of hookworm infection in the known area of its occurrence, and to detect its presence elsewhere in the United States, since the drafted men represent in the main an ideal cross section of the population owing to their ratio to the total population and the nature of their selection. It would hardly be possible by any other available method, except by a complete school survey, to secure as representative a group of the population in such a test. However, owing to the fact that Medical Department Form 55 *n*, used in reporting laboratory examinations of feces, does not give the home address of the patient, and to the fact that the routine hookworm surveys, with few exceptions, were not so conducted as to provide rosters with the home address or place of enlistment of the men examined except in a few isolated organizations, it was not practicable to furnish the geographical data in the amount desired.

METHODS USED FOR THE DETECTION OF OVA OF INTESTINAL PARASITES

Since no orders prescribing the method to be used in the detection of ova of intestinal parasites were promulgated by the Surgeon General's Office, it is appropriate here to describe some of the methods more commonly used throughout the camps, and to indicate their comparative values.

Because of the numbers to be examined, the nature of the available equipment, and the desirability of not encroaching on the duties of a medical staff already occupied with more important work, it was essential that any method used in detecting infection by intestinal parasites, such as hookworm, should be adapted to the utilization of an untrained and changing personnel in large part, and that it should not require elaborate apparatus or extensive laboratory equipment.

The direct microscopic examination of a sample of the fecal specimen is inaccurate and inadequate because of the minuteness of the sample used, and impracticable because of the length of time required to make a fair examination. The greater efficacy of the brine flotation-loop, described below, in the detection of the worm ova as compared with the ordinary smear method is shown in Table 89, in which daily examinations for nine-day periods are compared. Only hospital cases, based on records at Camp Jackson, are included in the table. The great variability in the daily hookworm percentages is probably due to the varying proportions of patients from the Northern States. The brine flotation method is obviously inferior in the detection of Strongyloides.

The centrifuge method was at once precluded by the difficulty, if not impossibility, of securing at the time an adequate number of instruments to accomplish a work of such magnitude, and the added difficulty of securing the requisite tubes and other glassware essential to equip and maintain facilities adequate to care for the number of examinations to be made in a survey of troops from the hookworm area of the South. It also calls for extraordinary care in cleaning the glassware used, for hookworm eggs are quite adhesive to the surface of glass. This is a difficulty of considerable importance when laboratory helpers are inexperienced, and adds much to the burden of supervision.

TABLE 89.—*Comparative results in detection of ova by direct smear and brine flotation-loop methods*

ORDINARY SMEAR METHOD

1918, June—	Number examined	Positive hookworm	Percentage positive	Remarks
10	205	13	6.3	During nine-day period the same examinations as that for the hookworm gave these percentages of other worms:
11	132	23	17.7	
12	153	24	15.7	Ascaris 1.1
13	135	19	14.1	Hymenolepis nana 0.6
14	150	11	7.3	Trichuris 0.3
15	116	9	7.7	Strongyloides 0.6
17	144	3	2.1	Oxyuris 0.0
18	106	14	13.2	
19	99	11	11.1	
Total	1,240	127	10.2	

BRINE FLOTATION-LOOP METHOD

20	109	40	37.5	During nine-day period the same examinations as that for hookworm gave these percentages of other worms:
21	96	34	35.4	
22	146	50	32.1	Ascaris 1.1
24	146	48	34.1	Hymenolepsis 0.8
25	152	39	26.2	Trichuris 0.8
26	128	26	20.3	Oxyuris 0.08
27	120	26	21.7	Strongyloides 0.0
28	120	22	18.3	
29	116	25	21.6	
Total	1,133	310	27.1	

The centrifuge is also inaccurate, undoubtedly because of the small size of the samples used. The standard fecal sample collected for this method in the Army is contained in a 2-dram vial. Negatives for hookworm by this method as used by the author in the department laboratory of the Southern Department were examined by the brine-flotation method and found in about 50 examinations to show a 40-per cent increase in infections. That is, the percentage was increased from 10 to 14. This ratio was borne out by the fact that, whereas the percentage of infection by the centrifuge method was about 8 per cent in 7,000 examinations, made in March, 1918, at the department laboratory, Southern Department, it rose at once to from 14 to 20 per cent among troops from the same general localities when the brine-flotation method was applied.

The sieve-sedimentation method of Hall is not adequate to the military necessities because of the fact that it can be operated only in a well-equipped laboratory and requires an expensive, elaborate, and somewhat permanent installation. It seems not to be rapid, and would require great care in cleaning to prevent a carrying on of infection when the sieves are used in rapidly succeeding examinations. Its accuracy in cases of light infections should also be tested The prime difficulty, however, with this method for hookworm survey is that arising from the possibility of carrying over ova from positive to negative stools and thus reporting a man for treatment who carried no infection.

BRINE FLOTATION-LOOP METHOD

In view of the difficulties, under Army conditions, attending the use of the methods referred to above, the method here described was devised after considerable experimentation. The method finally perfected by Kofoid and Barber

may be designated as the brine flotation-loop method. It consists in mixing a large fecal sample thoroughly in concentrated brine, in a paraffin paper can of from 2 to 3 ounces capacity, forcing the coarse float below the surface by means of a disk of No. 0 steel wool, and then allowing the can to stand not more than one hour nor less than 10 minutes for the ova to ascend. The surface film is then looped off with wire loops, one-half inch in diameter, and examined on a slide without a cover glass.

The method was tested in the Southern Department under the author's direction in more than 100,000 examinations of varying ratios and degrees of infection by about 75 different examiners, under diverse field conditions, and was found to be efficient and practicable.

Technique

The stools for examination were collected at reveille at the company latrines by a collecting squad consisting of 16 enlisted men in charge of a sergeant and under the supervision of a medical officer. The men from a given company were in charge of a line officer. They were marched to the latrine and the roll was called in alphabetical order from the roster by the sergeant in charge of the men. On admission to the latrine each man was identified and given a container, bearing the designation of the organization and his roster number, a sheet of waterproof paper, and half of a tongue depressor as a collecting stick. He was instructed to defecate on the paper and fill the can one-third full of feces. Men unable to furnish a specimen were given salts, under the supervision of the medical officer, and were moderately exercised. The men submitted their samples to the collector for inspection on leaving the latrine to prevent the passing in of empty cans. Substitution was forbidden. In practice this squad could collect the specimens from an entire regiment, make the first delivery at the laboratory at 7.30 a. m., and complete the collections at 10 a. m. On an average from 3 to 10 per cent of the organization on a complete roster failed to furnish specimens by reason of absence, detached service, or failed to defecate.

The receptacles used as containers for fecal specimens for examination for ova of intestinal parasites served not only to receive the fecal specimens at the latrines but also as the mixing dishes from which the ova subsequently were looped for examination, and themselves bore the results of their examinations to the recorder's table. The use of glass or tin containers was precluded by the cost, labor of cleaning, and danger of carrying over of infection by adhesion of ova to the sides of the dish; therefore, paper and pasteboard containers, which would be wasted afterwards, were used. In emergency, paraffined paper drinking cups and standard hospital sputum cups were used, but the most satisfactory container proved to be the standard 2-ounce paraffined paper drug can with tin bottom and paper top. Similar cans with paper bottom and top are more liable to be unsealed by the solvent action of the contents. Tin tops are advisable if specimens are to stand many hours before examination. Open drinking cups permit evaporation and increase the odor and liability of carrying over of ova by flies. Heavy paraffined "Kleen Kup" tumbler-shaped containers used in the grocery trade are satisfactory for shipping specimens some distance.

These have disk tops which may be forced into a groove. They are water-tight, preserve their contents admirably, and may be washed and used several times. They are difficult to write upon, except with wax pencil, difficult to open, and have an excess of surface exposure.

The drug cans which were used most extensively are about 1½ inches in diameter and 2½ inches high and are made up from specially constructed paper tubing made from stock paraffined on the inner face. Their capacity is normally 2 ounces and varies from 50 to 80 c. c. according to the brand or factory. Certain brands either have no coating or are so lightly coated that it was necessary to treat them to a dipping or to an inside coating of hot paraffin or sodium silicate to render them brine proof. Brine-proof cans, paraffin-coated on the inside that will resist soaking up by brine and feces for a number of hours can be obtained from commercial sources and are fairly satisfactory for this method of stool examination. The practical advantage of containers of these dimensions is that they will pack snugly in the compartments of the pasteboard fillers, which hold 3 dozen each, of standard shipping cases for eggs, which hold 30 dozen each. To facilitate the handling of a single filler, specially constructed pasteboard trays with tape loops for handles into which a single filler fits were used. These trays are very convenient for use in the preliminary marking of the cans, the arrangement of the numbered cans, and for subsequent handling at the latrines and in the laboratory.

In the examination of troops in the Army each can was marked with the designation of the organization and the roster number of the man whose specimen it was to receive. Thus, 305 Cav. H–16 was for the sixteenth name on the roster of Troop H of the 305th Regiment of Cavalry. Cans were at first marked on both top and side; the former for convenience in picking out a particular can at the latrine, the latter for use in the laboratory. These cans were marked with wax pencils or on strips of adhesive tape in ink on the tin tops, and the sides similarly marked, or with lead or colored pencil or in ink. Pasted typewritten labels are unsatisfactory, as they may soak off if wet or peel away if dry. The most satisfactory labeling proved to be that written in "Eternal" ink. This is not removed by water or brine, and sinks into the paper so deeply that it can not be rubbed off. It is also clearly visible on the wet can.

The cans for a given organization, such as a company or regiment, were serially numbered, and on receipt at the laboratory from the latrines were usually not in numerical order. In order to detect shortages, eliminate confusion of indistinctly written numbers, and facilitate entering results on the numerically and alphabetically serial roster, the cans were first arranged in numerical order on a number board and then racked in order in the sockets of serially numbered wooden racks holding 10 cans each. They were then passed to the mixing table, where they were prepared for the examiners.

The stool was prepared for examination by stirring the specimen thoroughly in concentrated brine with a small wooden stick until the brine was considerably discolored and the contained ova released from the feces. The amount of stool to be stirred varied with its consistency and composition. Not more than one-third of a canful ordinarily was used; if the sample submitted was too generous

the amount was reduced. The can was nearly filled with brine, and the stool, if puttylike and resistant, was broken up against the sides of the can. In some instances of puttylike stools the release of the ova was facilitated by scouring the stool up with steel wool on the end of the stick, against the side and bottom of the can. After stirring until the desired consistency was attained, a circular filter of No. 0 or No. 1 long fiber steel wool was carefully pushed down through the fluid to the bottom of the can with the stick. This effectively removed from the surface the lighter coarser float, broke up the air bubbles, and left the surface clear of coarse particles and suitable for looping the floating ova. Stirring the stool with the electric soda mixer gives quickly a suspension of the stool, but forms too many air bubbles for satisfactory looping. These may be quickly removed, however, by a few drops of alcohol or ether. If too much wool is used it will interfere with the ascent of the ova; if too little is used it will not remove the float. As a rule a lightly compressed disk, one-eighth to one-fourth inch in thickness, is sufficient. From 1 to 2 pounds are sufficient for 1,000 specimens. Other materials, such as disks of gauze or wire netting, or mats of excelsior and southern moss, will serve the same purpose, but less successfully by far. The southern moss may introduce fresh-water nematodes and their eggs and larvæ.

Since there was danger of cross contamination of adjacent cans through stirring and in putting in the wool by splashing over from one can to another, each can was removed from the rack during the preparation. As an additional precaution to prevent the accidental transfer of a stick from one can to another during the mixing of a rack of cans, it was customary to place sticks in all of the cans at the beginning of the work on the rack and leave them there when not in use until the entire rack was finished.

The specimen was prepared for microscopic examination by looping of the surface film to an ordinary glass slide. The loops for this operation were prepared from unraveled window screen or similar fine galvanized wire. They can be made up rapidly from 6-inch squares of wire netting by unraveling the mesh and twisting the individual wires into the loops. Each loop was formed around a glass tube or wooden cylinder about three-eighths of an inch in diameter, the shorter end twisted around the longer, which formed the shaft to close the loop, which was then bent out at right angles to the shaft. It was customary to let the cans stand for one hour to allow the ova to accumulate in the upper layers.

The following test shows the relative hourly abundance of hookworm ova in the surface film on a can mixed with brine at 8.45 a. m., until they disappeared: The brine and ova were poured off into another can at 9.15, being distributed, by the pouring, throughout the fluid. Four loopfuls were placed on the slide and 10 fields were examined. At 9.15 there were 69 ova recorded; at 10.20, 169, at 11.30, 150; at 1 p. m., 85; at 2.10, 20; at 3.15, only 3; and at 4 p. m., none. The temperature during the period was from 90° to 95°. The maximum number of ova appeared at the surface about an hour after they were uniformly stirred, and seven hours after mixing all had descended from the surface.

From tests made under other conditions it is evident that there is considerable variation in the rate of ascent and descent of the ova in the brine in different stools and at different temperatures.

The surface film will usually adhere to the wire when the submerged loop is lifted from the brine. Ova in the film are removed with it. It proved advisable to loop the surface near the sides as well as the center of the can. For this purpose the loop may be molded to the arc of the can on the one side. An acute angle in the loop at the base of the shaft is to be avoided as it tends to break the film.

The number of loopfuls necessary to make a fair sample for microscopic examination depends on the viscosity and contents of the film removed. About 10 loopfuls will skim the entire surface of the can and form a pool of brine conveniently handled on an ordinary microscopic slide with a mechanical stage. One skimming does not by any means remove all the ova, as they are not all in the immediate surface.

To secure the even spread of the looped film on the microscopic slide it is essential that slides be thoroughly cleaned with sulphuric acid-bichromate of potash mixture or with soap to remove all trace of fat. The custom of looping more than one sample on a single slide each in its penciled area is to be avoided because of the droplets which are sprayed about at times by the breaking of the film on the loop, and thus giving rise to cross contamination of the adjacent pool by an infected film.

For a time the author marked off an ellipse 1½ inches by three-fourths inch on the slide with a wax pencil to assist in confining the pool of brine on the slide, but this was later abandoned as unnecessary. It also increased the labor in cleaning the slide.

In the cases of viscid, opaque, and fatty stools, considerable dilution may be required. This may be done on the slide with a few drops of a mixture of equal parts of glycerin and brine stirred into the pool. The glycerin clears the more opaque particles and renders the ova more easily visible.

Contamination of the adjacent cans by droplets of the surface film splashing over from an infected can to a negative one may readily occur when the loop catches on a stray fiber of the steel wool and is suddenly released, or when the film in the loop breaks on contact with the slide. For this reason the can and slide should be moved away from the rack while the pool is being looped off.

The viscosity of the surface film may vary greatly with the nature of the stool. It is markedly decreased by slight additions of such disinfectants as tricresol and phenol (carbolic acid) or by alcohol, which is useful in removing air bubbles from the surface. Formaldehyde solution tends to curdle the mixture, and delays the ascent of the ova and reduces the numbers in the surface film.

These variables, which affect the opacity of the film examined and contents of the loop and the number of ova it removes, render any uniformity of looping and resulting thoroughness of examination practically impossible. In practice, from 3 to 7 loopfuls are generally used; but the number in the course of numerous examinations will vary from 1 to 20. It is obvious that these variables will introduce a margin of error in the detection of ova only among the lighter infections.

The surface of the pool of brine is thoroughly searched with the aid of the mechanical stage. To reduce the amount of focusing, the convexity of

the surface of the pool may be reduced by spreading it over the slide and extending the amplitude of the movements of the mechanical stage.

The microscopic equipment most useful is the typical high-grade instrument with 16 and 4 mm. objectives and ×5 or 6.4 and ×10 oculars or their equivalents. The searching is done with the low-power objectives and low-power ocular, since the latter is less tiring in long-continued examinations. For closer scrutiny the 4 mm. objective may be used with care on objects in the surface film without cover glass.

To render the ova more distinctly visible it is essential that the microscope be provided with a substage condenser and that the illumination be reduced by closing the iris diaphragm or lowering the condenser so as to increase the sharpness of definition of all objects in the field and to bring the egg membranes into relief. This assists in the quick differentiation of ova from objects of similar shape and opacity. The amount of searching necessary to make a fair examination is a function of so many variables that no arbitrary rule can be laid down. The degree of dilution, stirring, flotation, the amount of the surface fluid in the pool, its extent and convexity, the consistency and opacity of the fluid and its solid contents, the nature and number of the particles floated to the surface, the number and size of air bubbles, fat cells, oil globules, and starch cells all combine to complicate the search for ova. It is advisable to search a considerable area rapidly, and especially, in the case of opaque fluid and confusing particles, to search a part of the area minutely or make an additional dilution. Experienced examiners on an average give from two to three minutes to the examination of a specimen containing on an average four or five loopfuls spread over an area of approximately 1.5 square inches on the slide.

Infected stools, or positives, are usually detected in the first field or run across the slide examined. In a test case of 550 positives of hookworm, most of them very light infections, in Oklahoma and Texas recruits, detected on five consecutive days by five experienced examiners and recorded as found or not in the first run across the slide, there were 180, or 30.5 per cent, reported as seen in the first run. Infections obviously reduce the time required for examination in most cases. In a relatively few cases, estimated at not more than 5 per cent, with the examination of more than 150,000 men in the Southern Department (Texas, Oklahoma, New Mexico, and Arizona), several ova only were found in the whole slide examined. In rare instances only a single ovum is found. These very light infections and the negatives require more time for a complete examination than do other positives.

It is obvious that the rate of examination and daily score of the examiner will be in part a function of the ratio of positives to the whole and of the average degree of infection. With numerous positives and heavy infections, which are usually coincident, the rate of the expert examiner may easily be doubled over that when positives are few and infections are light. The experience, skill, industry, and thoroughness of the examiner are also factors determining his daily score, as well as the nature of the stools as conditioned by diet and modified by the skill or lack of it on the part of the mixers.

A skilled examiner will complete from 150 to 250 examinations daily under average conditions. With the assistance of a looper the rate can be

speeded up to one per minute; or over 400 per day, but the resulting eye strain renders this inadvisable as a daily routine. A staff of 15 examiners can maintain a rate of from 2,000 to 2,500 examinations daily and attain 3,000 under favorable conditions of cooperation and effective supervision of the mixers. A staff of 20 examiners can complete a full regiment daily. Supplemental aid of approximately one man in the field collecting squad, in case the collecting is done by the men attached to the surveying board, and one man in the laboratory and clerical squad for each examiner is necessary to collect, prepare, record, and dispose of the specimens and attend to the policing of the laboratory.

The time required for the physician inexperienced in laboratory work to become efficient in this method is brief. Enlisted men with some experience in college, university, or Army laboratories acquired a reliable degree of accuracy with several days' training and supervision, as shown by test. Insistence upon focussing upon the surface film and a preliminary exercise and testing out in stools with known infections are essential in preparation for this work.

The ova of parasites such as *Ancylostoma duodenale, Necator americanus, Ascaris lumbricoides, Oxyuris vermicularis, Trichuris trichiuria, Tænia solium, Hymenolepis nana, Hymenolepis diminuta,* and *Dipylidium caninum* and of trematodes, are floated up by the brine into the surface layer of the pool without distortion or noticeable change in appearance during the usual period of examination. Cysts of *Entamœba coli* and *histolytica* and of *Giardia intestinalis* are also floated up. Since the ova are at the surface, it is not advisable or necessary to use a cover glass.

Modifications of the Brine Flotation-Loop Method

The exigencies arising in the Army from the shortage of supplies for the brine flotation-loop method, and the devices of officers responsible for the hookworm survey gave rise to a number of modifications of the original method. The simplest of these is Barber's method, in which a good-sized lump of feces is mixed with glycerin and saturated sodium chloride solution (proportions not important) and a drop of the mixture placed on a slide ringed with a wax pencil. The eggs float to the surface and rise to the center of the drop.

The following modification of the brine flotation-loop method was made at Camp Jackson, S. C., for routine hospital examinations and for a number of stools sent from the camp:

Specimens were sent to the laboratory in tin containers provided with lids. Brine flotation and loops were used exactly as in the method described above, but instead of filtration by steel wool the coarser floating particles were skimmed off by means of a spoon before the ova had time to rise. The spoon was scrubbed with a brush and carefully washed under the hot-water tap after each use. When cans were used a second time they were very carefully cleaned and dried.

It is obvious that the main advantage of this modification is in the saving of materials rather than of labor. Further, it is adapted only to work on a comparatively small scale and in a laboratory supplied with trained workers and with a hot-water tap for the proper cleaning of utensils. It is not to be

recommended for field work on a large scale or for any work in which pasteboard containers and steel wool are obtainable, or where expense for labor is a factor. The possibility of removal of some of the ova by this method is not precluded.

The lack of the drug cans led to the use of standard hospital sputum cups for collection and stirring in brine. These answer the purpose, but they are less substantial than the drug cans, more difficult to stir in, attract flies (because they have no cover), permit the stools to dry up on standing, and owing to their proportions they give a greater dilution of the ova in the surface film. For these reasons they are to be avoided when feasible.

Accuracy of the Brine Flotation-Loop Method

The accuracy of the method may be reviewed from the standpoint of its relative efficiency as compared with other methods, considered above, with the conclusion that, with the exception of the culture method, it offers the highest attainable degree of accuracy, with a maximum rapidity, and a minimum amount of labor in cleaning and loss by breakage, and a minimum of expense for materials used.

Not all positives can be determined by any method short of autopsy after sudden death, for worms may be voided during sickness as a result of, or treatment for, disease, or males only may be present. Owing to variations in the physiological states of host and parasite, ovaposition is subject to irregularities resulting in marked changes in numbers of ova discharged in the stool, with the result that quite independently of the accuracy of the examiner or of the technique employed, the infection is not revealed in the stool. Within an as yet unknown and presumably variable range of materials, the size of the sample examined, as determined by the size of the sample collected, on the one hand, and by the amount of material subjected to uniform scrutiny by the examiner, on the other, sets a certain limit to the accuracy of the work. Large samples will yield more positives than small ones in light infections, but no method in itself will reveal ova in the stool when the worms are not ovapositing. Repeated examinations on successive days, or at intervals, are necessary to establish a negative.

The relative accuracy of this method, among examiners and specimens, depends on a number of variables, the size and consistency of the specimen, the thoroughness of stirring, the proper amount of steel wool, the care in looping, the opacity of the fluid, and the extent and thoroughness of search made of the material on the slide. Much depends on keeping the focus directly on the surface of the fluid during examination and in training the eye to detect quickly every object resembling an ovum.

The cases of infection which escape detection are the very light ones in which only a few ova can be found on a slide. Some slides prepared from such infections may have no ova, or the ova may be hidden or overlooked.

Reexamination of slides and cans that are reported by an experienced examiner as negative will sometimes reveal a positive, lightly infected. Men reported as negative on a first examination may appear as positive on a second, and vice versa. This raises the question as to the uniformity of distribution of

the ova in the stool and as to the possibility of internal states of host and of parasite influencing the rate of deposition of ova in successive stools.

With a view of testing out the possibility of light infections having been overlooked, an examination was made of 100 negatives from colored troops at Camp Travis, Tex. Infections in the battalions from whom these negatives were drawn were only 68 in 1,495, or 4.8 per cent. The infections were also light, as a rule. The top fluid of 50 cans was drawn off into a tall cylindric liter graduate and the surface film of this column examined. The cans had stood after stirring for less than three hours, and no brine from thick or viscous stools was used, so as to avoid entangling any ova that might be present. This was repeated on a second 50 and the top fluid of the two lots combined in a slender 50 c. c. graduate. An examination of the surface film of each of these concentrations gave negative results. A subsequent examination within two hours of flotation of 150 negatives by the same method from white troops, showing 219 positives, or 8.7 per cent, in 2,505 examinations, revealed 1 case of an ovum in 1 lot of 50. The other two lots remained negative. In another test of 3 lots of 50 each from white and colored troops showing 110 infections, or 5.7 per cent, in 1,914 examinations, all remained negative. In a total of 550 negatives, or 11 lots of 50, of light and therefore presumably easily overlooked infections, only one lot showed evidence of an undetected infection on this test.

It appears from these tests that the number of positives escaping detection by the brine flotation loop method is small. These tests were made in the negatives from 16 examiners, 13 of whom were enlisted men and 8 of whom had only from 3 to 9 days experience with hookworm examinations.

No opportunity occurred for a comparison of this flotation method with the culture method to compare their relative accuracy on identical stools.

GEOGRAPHICAL DISTRIBUTION OF HOOKWORM INFECTION IN THE UNITED STATES

Examinations of recruits for hookworm in the Army camps, conducted by the Medical Department in accordance with the instructions previously referred to, afforded unique opportunities of detecting the extent and distribution of infection by this human parasite. The distribution thus detected is not that of the infected population of the country as a whole, but rather that in a selected group of able-bodied men, most of whom had already run the gantlet of one or more medical examinations, and were, at the time of the examination, in Army camps on duty as able-bodied soldiers, or in some stage preparatory to this status. They presented, therefore, to a considerable degree, a selected group, since the obviously sick had been excluded.

The data also include only males, presumably the sex most exposed to infection. Furthermore, the males included were not those of all ages, but only those of military age, the general body of whom were between the ages of 21 and 30, with certain numbers below 21 and above 30. They represented a fair sample of able-bodied young men of the United States of southern residence or exposure with but slight modifications due to selective factors and class of occupation. These selective factors would tend to modify somewhat the representation of classes most liable to infection, especially in some cases, such as agricultural exemptions, which tended to counteract the inclusion of the normal representation from agricultural districts in the hookworm area.

Not all of the States are represented equally in the data, since the orders of the Surgeon General's Office covering these examinations provided only for the examination of men who entered the Army from the hookworm area, or had resided there for six months or more, or who had formerly lived in that area but had emigrated to other States of the Union. Percentages of infection therefore which appear for States other than those of the hookworm area are not representative of the normal population of those States, but rather of a selected group of persons who lived within the area of distribution of hookworm and thus came within the possibility of exposure to infection by hookworm.

Our data, therefore, are fairly representative of the normal population of males of military age only for States of the hookworm area and only those males of military age who in other States might have acquired the infection by reason of southern residence.

The total number of men examined for hookworm in the United States Army during the war and so reported to the Surgeon General was 501,472; of these, 56,740, or 11.3 per cent, were found to be infected with this intestinal worm, upon one examination as a rule. Had repeated examinations been made by the brine flotation method in all cases this percentage would have been increased, perhaps from 25 to 50 per cent. Unfortunately the Army records did not permit the allocation of these men to the States of their birth, residence, or enlistment in most of the cases. This was feasible, however, in the case of 126,140 men.

In order that the contrast between the different areas of the United States may be set forth in their relations, the statistics have been grouped under four heads: States in the hookworm area (16 and District of Columbia); 10 of the Northeastern States; the 13 States of Northern Mississippi Valley, or Middle West; and 10 of the Pacific Slope, including Alaska.

TABLE 90.—*Hookworm infection in States in the hookworm area*

State of birth	Per cent positive	Number positive	Number of men examined	State of birth	Per cent positive	Number positive	Number of men examined
Alabama	29.4	656	2,223	North Carolina	27.1	3,402	12,558
Arkansas	6.4	787	12,292	Oklahoma	6.9	607	8,686
District of Columbia	1.6	2	121	South Carolina	23.5	1,918	8,135
Florida	31.8	1,202	3,778	Tennessee	12.6	1,233	9,722
Georgia	32.6	1,265	3,872	Texas	11.7	3,494	29,837
Kentucky	16.3	376	2,301	Virginia	6.7	65	969
Louisiana	27.3	2,010	7,348	West Virginia	3.7	36	972
Maryland	2.1	12	584				
Mississippi	27.1	2,358	8,684	Total	17.01	19,464	114,408
Missouri	1.8	41	2,326				

TABLE 91.—*Hookworm infection in the Middle West—Mississippi Valley*

State of birth	Per cent positive	Number positive	Number of men examined	State of birth	Per cent positive	Number positive	Number of men examined
Illinois	1.4	17	1,153	North Dakota	0	0	82
Indiana	1.7	10	582	Ohio	3.5	45	1,277
Iowa	.4	2	418	South Dakota	1.6	1	63
Kansas	.8	3	354	Wisconsin	.7	2	278
Michigan	1.0	7	665	Wyoming	0	0	41
Minnesota	1.5	5	325				
Montana	1.2	1	81	Total	1.69	96	5,664
Nebraska	.9	3	345				

TABLE 92.—*Hookworm infection in the Northeastern States*

State of birth	Per cent positive	Number positive	Number of men examined	State of birth	Per cent positive	Number positive	Number of men examined
Connecticut	1.5	4	265	New York	.7	11	1,479
Delaware	8.7	2	23	Pennsylvania	.3	4	1,074
Maine	.9	2	216	Rhode Island	1.3	1	73
Massachusetts	.1	9	813	Vermont	1.1	1	84
New Hampshire	14.2	2	47				
New Jersey	.3	1	284	Total	.84	37	4,358

TABLE 93.—*Hookworm infection in the Pacific Slope States*

State of birth	Per cent positive	Number positive	Number of men examined	State of birth	Per cent positive	Number positive	Number of men examined
Alaska	0	0	1	New Mexico	2.6	9	345
Arizona	3.1	4	128	Oregon	2.4	2	81
California	2.0	11	527	Utah	3.2	2	61
Colorado	2.4	9	368	Washington	2.1	3	137
Idaho	2.7	1	38				
Nevada	8.3	2	24	Total	2.5	43	1,710

SUMMARY

Total number of men examined	126,140
Total number positive	19,640
Per cent infected	15.5

The number of men examined, according to these tables, is 126,140, among whom 19,640, or 15.5 per cent, were found to be infected by hookworm. The percentage of infection in the men outside the hookworm area owes its origin to two factors, the relative importance of which it is not possible, owing to the nature of the data, to disentangle from available records. These two factors are infection due to birth or residence in childhood or later life in States of the hookworm area, on the one hand, and, on the other, to exposure in southern Army camps or service on the Mexican border on the part of recruits in the Army in the years prior to the World War, and service in Army camps in the hookworm area for more than six months after the United States entered the war. Owing to the sanitary supervision in Army camps, it is highly improbable that many cases of hookworm infection could have been acquired by men of the latter group during their period of Army service. The inclusion of these two groups of men among those accredited to States outside the hookworm area undoubtedly has tended to decrease the percentage of infection reported for these States. Had the examinations been limited to men of southern birth or residence outside of Army service the percentage would possibly have been higher, because of the varying degrees of sanitary supervision during periods of residence and the tendency for many of these periods of residence to have been more prolonged than those of Army recruits.

In view of these considerations, it is evident that the degree of suspicion of hookworm infection which attaches to persons of birth or residence in the hookworm area and subsequent migration to States outside of that area must be somewhat higher than that suggested by the percentages of infection here reported. Thus, for example, in the State of Illinois, in which 1,153 men were examined, there were 17 men, or 1.5 per cent, found to be infected with hookworm. It happens that Illinois recruits at Camp Logan, Tex., who had been

there for more than six months, were examined for hookworm and constituted a considerable proportion of the persons accredited to that State. In that camp, among 7,539 patients at the hospital, 7.4 per cent were found to be infected, while in 4,807 men on duty in the 15th Division, the percentage was 2.4. This percentage is higher than that accredited to the State of Illinois, because of the infiltration into this camp of other recruits, largely from the hookworm area. It is impossible to determine the extent to which the 2.4 per cent among troops on duty in this camp was due to infections acquired during residence therein, or to determine in what degree the 1.5 per cent accredited to the State of Illinois was due, on the one hand, to migration from the South into that State, and, on the other hand, to local infection acquired by recruits born in Illinois and subsequently residing in the southern Army camps. The presumptive evidence is against the acquirement of the infection in the camps, owing to the sanitary supervision of food and of latrines and the wearing of shoes. Only under the most exceptional circumstances would a recruit be exposed to infection by contact with polluted soil or food or water.

Certain sources of error are inevitable in so large a mass of data as this, gathered under circumstances so diverse. These errors arise from varying methods of examination. All of the examinations are subject to errors arising from a single test. Repeated tests would undoubtedly have increased the number of infections perhaps as much as 30 per cent, and 10 per cent if examined by the brine-loop method. The lighter infections by few worms are often overlooked or undetected in cases of a single examination only. The percentages of infection here reported fail to represent adequately the degree of infection prevalent, because of the fact that the group of men included are of the age in which infection acquired in childhood is gradually dying out, especially in cases under consideration in which changes ensued from rural to urban life and from barefoot days to those of the constant wearing of shoes. These changes cut off the opportunities for renewed infection, and combined with the dying out of worms from old age, tend to eliminate in the older men of the group the infection of earlier years.

Imperfect as these figures of necessity are, still they indicate that there is much to be done in sanitary supervision, not only in military camps but by local and State boards of health, by educational agencies, by industrial organizations, and by other institutions interested in the improvement of the sanitary conditions and of the health and efficiency of the community.

INTESTINAL PARASITES IN CERTAIN OF THE OVERSEAS AND HOME-SERVICE TROOPS

In the Army laboratory, port of embarkation, New York, from December 28, 1918, to July 1, 1919, examinations were made of 2,300 men of the United States Army who had been overseas and of 576 men from home-service troops. The overseas troops examined were sick and wounded soldiers in transit through Debarkation Hospital No. 3, New York City; they were drawn from over 800 different military organizations, and therefore were fairly representative of our overseas troops. They came from every State in the Union and constituted approximately a fair example of our population. Only a small fraction of them saw service on the Mexican border.

The home-service troops were mainly cooks, bakers, and food handlers from the port of embarkation, principally from the Medical Department. Of the total of 576 men examined, about 30 per cent were of foreign origin—Russian, Polish, Italian, or Spanish—or were negroes from Florida. This group, therefore, was less typical of the American troops as a whole than was the overseas group examined. They presumably presented a higher degree of infection by reason of their origin than would a fair sample of our population.

The relative degree of infection in these two groups of men was striking, as will be shown later, but it is obviously impossible to determine what proportion of the infection detected in the first group was acquired overseas and which was of home origin.

For the determination of infections, reliance was placed mainly upon the microscopical analyses of ova and cysts in the fresh stools. Different methods for the protozoa and for helminths were used in this analysis, the ova of the latter appearing in only a small number of cases in the direct smear method, which proved most useful for the former. For the protozoan examination a modified Donaldson's iodine-eosin stain was used. The smear is prepared for microscopical examination by rubbing out a minute bit of the feces by rolling it on a round applicator stick in a small drop of normal salt solution and then in an adjacent drop of the iodine-eosin stain. A single cover is placed on both drops and the smear is ready for immediate examination. Living flagellates, active amebæ, and unstained cysts appear in the unstained part. In the stained area the bacteria, fecal particles, and the smaller intestinal yeasts stain at once. Against the pink background the protozoan cysts stand out clearly as bright, greenish spherules, which soon become tinged by the iodine to varying tones of yellow. When glycogen-laden vacuoles are present they become light or dark brown, according to their mass. The nuclei, which at first are scarcely if ever visible, become more clearly defined as the iodine penetrates, expecially in *Entamœba coli* and *histolytica*. They are detected with difficulty in this stain in *E. nana*.

The component solutions of this stain were prepared in physiological salt solution and the proportions of iodine as given in the original formula were reduced. The formula is used as follows:

	Parts
Saturated solution eosin in normal salt	2
Five per cent KI in normal salt saturated with iodine	1
Normal salt solution	2

Also the concentration method of Cropper and Rowe (1917), as modified by Boeck (1919), was used on over 2,000 stools as supplemental to the direct smear, but less than 10 per cent was added to the number of infections detected by the direct smear method. A few trials of the Carles-Barthelomy (1917) citric-formalin method also were made. The added infections were mainly of *E. coli*, which is rarely abundant, a few light infections of *E. nana*, and a few cases of Giardia. It is probable that the detection of light infections of *E. histolytica* would be facilitated by these methods, but the time required is greater and the percentage of infections detected thereby very small. The direct smear is simple, rapid, and in our experience both efficient and reliable for practical purposes. Concentration methods were useful in research and in following up difficult and suspected cases.

In nearly all cases of infections with *Entamœba histolytica* and with the smaller races of *E. nana* preparations were made by the wet smear and stained with Heidenhain's slow iron hematoxylin. This also was used to confirm the analyses made in all doubtful cases.

Examinations for ova of intestinal worms were made by the brine-loop method.

A single examination only was made in most cases. The exceptions to this were 60 men from overseas and 71 of the home-service troops, from whom two or more samples were secured for examination. In the overseas group the reexamination of 60 cases with a total of 129 examinations, or 2.15 examinations per individual, increased the number of different infections detected from 75 to 123, or from 1.25 to 2.05 per individual. Thus the first examination revealed 60.9 per cent of the infections found in 2.15 examinations. In the home-service group the examinations of 25 cases, with a total of 57 examinations, or 2.3 per individual, increased the number of infections detected in these cases from 47 to 93, or from 1.9 to 3.7 different infections per individual. In this group the first examinations revealed 50.5 per cent of the infections found in 2.3 examinations per individual.

In view of the large percentage of cases in which it was possible to make only one examination, it is highly probable that the total percentage of men infected among those examined is considerably higher than our records indicate, particularly for protozoan infections.

There has been little, if any, selection of cases for examination. The data represent the average run of the sick and wounded men received at Debarkation Hospital No. 3 from overseas, and of food handlers, etc., of the port. They were not, as a rule, dysenteric patients, though many of the positives carrying cysts of *Entamœba histolytica* reported one or more attacks of diarrhea or dysentery, in some cases with treatment, while on duty overseas.

TABLE 94.—*Summary of infections by intestinal parasites in 2,300 overseas troops and 576 home-service troops of the United States Army*

CASES OF INFECTION

	Total	Negative	Positive	Cestoda			Nematoda			Rhizopoda						Flagellata					Miscellaneous		
				Dibothriocephalus latus	Hymenolepis nana	Tenia saginata	Hookworm	Trichuris trichiura	Ascaris lumbricoides	Entamœba coli	Entamœba nana	Entamœba histolytica	Entamœba gingivalis	Dientamœba fragilis	Amœba limax	Trichomonas hominis	Cercomonas intestinalis	Waskia intestinalis	Chilomastix mesnili	Giardia intestinalis	Sporozoa	Blastocystis hominis	Phycomycete spore
Overseas	2,300	763	1,537	0	10	0	160	136	26	473	675	297	1	1	3	3	3	4	97	131	7	784	194
Home service	576	243	333	1	3	2	22	14	1	92	161	25	1	1	1	3	1	4	20	37	4	181	57

PERCENTAGES OF INFECTION

Overseas	2,300	33.1	66.9	0	0.4	0	6.9	5.9	1.12	0.5	29.3	12.8	0.1	0.1	0.1	0.1	0.2	0.2	4.2	5.7	0.3	34.1	8.4
Home service	576	42.2	57.8	.2	.5	.3	3.8	2.4	.21	59	27.8	4.3	.2	.2	.2	.5	.2	3.5	3.5	6.4	.7	31.4	9.8

As shown in Table 94, the infected men (1,533 or 66.6 per cent) were relatively more numerous in the overseas group than among those who had only home service (345 or 59.9 per cent) and on computation it appears that overseas men averaged 1.2 infections by different parasites per man as contrasted with 1.03 infections for men having home service only. These results indicate that many of the infections were presumably carried overseas and not acquired there in the first instance, although there is some evidence that many overseas men carried heavier infections than did home service troops. In determining the significance of this difference the source of the home service troops previously referred to should be considered. It may be that the percentages of infections found among them were somewhat higher than they would have been in the more representative troops on their departure overseas, and that the infections acquired abroad were in reality more numerous than our data reveal.

An analysis of the data in the tabulation given above exhibits certain very significant features. In the first place the men with hookworm infections were all, with 13 exceptions, from the known areas of hookworm occurrence in this country. There is thus slight indication of the acquisition of this infection overseas.

In the case of *Trichuris trichiura*, a different condition is found. In home service troops there were 14 infections, or 2.4 per cent, while in the overseas troops there were 136 infections, or 5.9 per cent. In the home service troops seven of these infections were in recent immigrants from Europe and two were in negroes from Florida. Deducting the number of these immigrants, the percentage of infection in the remaining falls from 2.4 to 1.2, but even this percentage is probably not representative of our troops on departure overseas. An examination of the stools of 145,016 men in the Southern Department revealed only 162 cases of infection by *Trichuris trichiura*, or 0.1 per cent. These were men mainly from Texas and Oklahoma, but representatives of every State in the Union were included. In a total of 501,472 examinations reported to the Surgeon General there are 1,945 cases of Trichuris, or 0.38 per cent.

HELMINTH INFECTIONS IN OVERSEAS AND HOME SERVICE TROOPS

The infections which are of significance have already been referred to in the discussion of fecal infection in overseas troops. A more detailed account of the results of the examinations for helminths in the two groups of soldiers will now be given.

A tabular summary of 437 examinations of home service men and 2,253 from overseas follows.

TABLE 95.—*Infections by hookworm and Hymenolepis nana in men from Northern States*

State	Overseas						Home service					
	Hookworm		Hymenolepis nana		Negative	Totals	Hookworm		Hymenolepis nana		Negative	Totals
	Number	Per cent	Number	Per cent			Number	Per cent	Number	Per cent		
Arizona	1	16.7	0	0	5	6	0	0	0	0	1	1
California	1	1.9	1	1.9	51	53	0	0	0	0	9	9
Colorado	1	6.2	0	0	15	16	0	0	0	0	3	3
Connecticut	0	0	0	0	33	33	0	0	0	0	4	4
Delaware	0	0	0	0	2	2	0	0	0	0	2	2
Idaho	0	0	0	0	7	7	0	0	0	0	1	1
Illinois	0	0	1	.7	140	141	0	0	0	0	18	18
Indiana	0	0	0	0	61	61	0	0	0	0	10	10
Iowa	0	0	0	0	55	55	0	0	0	0	3	3
Kansas	0	0	0	0	43	43	0	0	0	0	2	2
Maine	0	0	0	0	15	15	0	0	0	0	15	15
Massachusetts	1	1.2	1	1.2	79	81	1	3.1	0	0	31	32
Michigan	1	1.2	0	0	79	80	0	0	0	0	30	30
Minnesota	1	1.3	0	0	73	74	0	0	0	0	8	8
Montana	1	5.9	0	0	16	17	0	0	0	0	0	0
Nebraska	0	0	0	0	11	11	0	0	0	0	2	2
Nevada	0	0	0	0	1	1	0	0	0	0	0	0
New Hampshire	1	9.1	0	0	10	11	0	0	0	0	5	5
New Jersey	0	0	0	0	57	57	0	0	1	2.6	38	39
New York	2	.7	1	.4	264	267	1	1.1	1	1.1	85	87
North Dakota	0	0	0	0	9	9	0	0	0	0	2	2
Ohio	1	.8	0	0	122	123	0	0	0	0	12	12
Oregon	1	5.9	0	0	16	17	0	0	0	0	2	2
Pennsylvania	0	0	1	.5	186	187	1	1.7	0	0	56	57
Rhode Island	0	0	0	0	15	15	0	0	0	0	2	2
South Dakota	0	0	0	0	9	9	0	0	0	0	1	1
Utah	0	0	0	0	8	8	0	0	0	0	0	0
Vermont	0	0	0	0	8	8	0	0	0	0	6	6
Washington	0	0	0	0	29	29	0	0	0	0	3	3
Wisconsin	1	1.7	0	0	58	59	0	0	0	0	17	17
Wyoming	0	0	0	0	7	7	0	0	0	0	0	0
Total	13	.9	5	.3	1,484	1,502	4	1.1	2	.5	368	373

TABLE 96.—*Infections by hookworm and Hymenolepis nana in men from Southern States*

State	Overseas						Home service					
	Hookworm		Hymenolepis nana		Negative	Totals	Hookworm		Hymenolepis nana		Negative	Totals
	Number	Per cent	Number	Per cent			Number	Per cent	Number	Per cent		
Alabama	18	40.0	1	2.2	26	45	1	16.7	0	0	5	6
Arkansas	4	11.8	0	0	30	34	0	0	0	0	3	3
Floridia	10	37	0	0	17	27	2	13.3	0	0	13	15
Georgia	25	50	0	0	25	50	3	43.3	0	0	4	7
Kentucky	10	18.2	0	0	45	55	0	0	0	0	4	4
Louisiana	8	19.5	0	0	33	41	0	0	0	0	4	4
Maryland	0	0	0	0	21	21	0	0	0	0	5	5
Mississippi	6	17.1	0	0	29	35	0	0	0	0	0	0
Missouri	0	0	0	0	78	78	0	0	0	0	5	5
New Mexico	0	0	0	0	7	7	0	0	0	0	0	0
North Carolina	13	26	0	0	37	50	2	40	1	20	2	5
Oklahoma	6	11.5	1	1.9	45	52	0	0	0	0	0	1
South Carolina	13	33.3	1	2.6	25	39	1	100	0	0	0	1
Tennessee	10	22.2	0	0	35	45	1	100	0	0	0	1
Texas	7	7.3	1	1	88	96	0	0	0	0	3	3
Virginia	11	26.8	0	0	30	41	1	20	0	0	4	5
West Virginia	1	3	1	3	33	35	1	33.3	0	0	2	3
Total	142	18.8	5	.6	604	751	12	18.5	1	1.5	51	64

As shown in the above tables, there were only 13 cases of infection by hookworm, or 0.9 per cent, among 1,502 men from Northern States from overseas, and 4 among 373 home service, or 1.1 per cent. In the case of 757 men from the hookworm area, with overseas service, there were 142 infections, or 18.8 per cent, while in 64 home-service men from that area there were 12, or 18.5 per cent. The differences between infections in home-service men and overseas men by hookworm are not the probable error and do not show any clear evidence of any increase in the infection due to overseas experiences. There is likewise no evidence that overseas men had an increased infection of *Hymenolepis nana*. In fact, among home-service men, largely food handlers, this infection was heavier than among overseas men, both among the northern and southern men.

In the case of infections by *Trichuris trichiura*, the case is different. We have here an infection carried to new human hosts in the unhatched egg stage. The ova are discharged in an undeveloped stage, and do not hatch to a larva stage until taken into the digestive tract of man. After discharge with the feces, the egg of Trichuris may live in moist earth or water for not less than five years under experimental control. Presumably at any time in this period, if taken into the digestive tract of man, it develops into the adult worm.

Whenever sanitary provisions for the proper care of human sewage are defective or imperfectly observed, wherever night soil is deposited in fields or gardens which drain into water supplies or near springs used for drinking purposes, opportunities for infection may be afforded. Wherever flies have access to freshly deposited or accumulated feces and at the same time to kitchens and mess halls, or food in any stage of its preparation prior to cooking, they may carry the ova on their feet from the feces to the food and thus infect it.

The degree of infection of any population or body of soldiers by whipworm is a measure of the effectiveness of the sanitary protection from infection by organisms of human feces under which they have been living for several years prior to the examination. The same conclusions may be derived from the degree of infection by *Ascaris lumbricoides* for similar reasons.

The infection by these two helminths in the United States does not have a distribution similar to that by hookworm, but is affected by two diverse factors: Immigration from the more highly infected regions in the south of Europe, and by sanitary conditions in the Appalachian Mountains region, especially in coal mining and cotton mill centers. Eastern Kentucky and Tennessee and West Virginia appear to be centers of infection by these two helminths.

The total number of infections by Trichuris and by Ascaris reported in all records compiled in this report were 1,862 and 3,013, respectively, for over 450,000 examinations, or 0.4 and 0.6 per cent, respectively. In the overseas men the total infections by these two helminths were 136 and 26, or 5.9 and 1.1 per cent, respectively. This is a fifteenfold increase in the case of Trichuris in overseas men as compared with the body of troops surveyed and a twofold measure in Ascaris. Since the southern men formed only about one-third of the overseas men examined and made up the greater part of the surveyed before going overseas, it is highly probable that the increase in infections by these helminths as a result of the overseas service was in reality considerably

greater than we have computed it to be. This increased infection by these helminths appears to have been the direct result of overseas service, and to have been caused by fecal infections of food and water.

The presence of such carriers of amebic dysentery constitutes a menace to the health of armies in field operations, of troops in camps, and of the communities in which they may reside later, especially where sanitation is neglected and the fly nuisance prevails. The number of cysts discharged daily by a carrier of amebic dysentery varies greatly according to the degree of infection. A moderately infected case of *Entamœba histolytica* was kept under daily observation and examination for 42 days and the whole stool stirred to a uniform suspension and diluted to 500 and 1,000 c. c. in normal salt solution. The numbers of cysts of Giardia, *Entamœba histolytica*, and *E. coli* were determined in the counting chamber of a hemocytometer and computed for the stool as a whole, with the result that *E. histolytica* cysts were found on 26 of the 42 days in numbers ranging from 330,000 to 45,000 per day, averaging 14,520,000 for the 26 days, or 8,145,000 for the whole period of 42 days. Cysts of *Giardia intestinalis* were present on only 17 of the 42 days in numbers varying from 5,000,000 to 3,625,000,000 per stool, and averaging 925,200,000 per day. *Entamœba coli* was much rarer, being found in this case on only 3 of the 42 days, with an average of 3,110,000 cysts per day for the 3 days. The margin of error in these computations is large, but after due allowances are made for this, the number of cysts discharged by carriers is still large enough to provide for a wide dispersal of the cysts by flies or other agents. The sizes of these cysts range from 5 to 20 microns in the main, most of them are from 7 to 15 microns in diameter, and are thus of such volume that they could easily be carried on the foot of a fly. Computations show that 100 to 150 of the larger cysts and 500 to 2,000 of the smaller ones could be crowded in the area of a fly's foot in a single layer.

The possibility that the carrier problem in the case of amebic dysentery and other human protozoan infections is a much larger one than hitherto recognized is raised by the data here presented. Furthermore, the findings among home-service troops are indicative that the endemic area of infection by *Entamœba histolytica* in the United States is not confined to the Southern States.

CHAPTER XX

DISEASES OF THE SKIN [a]

Diseases of the skin, exclusive of dermatological manifestations of venereal disease, though ordinarily considered to be of minor importance in so far as danger to life is concerned, are of great importance to an army operating in the field, by reason of the noneffectiveness they cause. This was true of past wars and equally so of the World War. During the Civil War, for example, 74,182 cases of skin disease were reported,[1] divided as follows: Itch, 35,236; "skin diseases," 38,946. As to the true nature of the condition termed itch, there was considerable doubt,though many observers declared that the only difference to be observed between the reported cases of itch and scabies was one of degree; that is to say, the soldiers neglected to apply for treatment until after they had been completely covered with the eruption.

That the incidence of skin diseases in our Army during the World War was considerable also is shown by the following tabulation.

TABLE 97.—*Diseases of the skin and cellular tissue. Primary admissions, officers and enlisted men, United States Army, April 1, 1917, to December 31, 1919. Absolute numbers*

	United States	Europe	Total		United States	Europe	Total
Carbuncle	1,515	815	2,330	Impetigo	1,456	1,279	2,735
Furuncle	15,806	4,152	19,958	Lichen	76	13	89
Abscess	11,868	4,461	16,329	Pityriasis	471	108	579
Cellulitis	9,278	3,546	12,824	Psoriasis	903	603	1,506
Trichophytosis	2,299	514	2,813	Scabies	12,099	22,035	34,134
Ectoporasitism	1,703	1,566	3,269	Skin and cellular tissue, other diseases of	13,277	6,993	20,270
Dermatitis	707	151	858				
Eczema	2,898	1,137	4,035				
Erythema	1,173	322	1,495		77,885	48,480	126,365
Herpes	2,356	785	3,141				

In addition to the occurrence of skin diseases, as shown above, such diseases were concurrent with other diseases for which admission to hospital was made, in the following numbers:

Carbuncle	158	Impetigo	328
Furuncle	1,763	Lichen	19
Abscess	3,681	Pityriasis	238
Cellulitis	1,718	Psoriasis	356
Trichophytosis	411	Scabies	2,926
Ectoparasitism	741	Skin and cellular tissue, other diseases of	4,911
Dermatitis	150		
Eczema	663	Total	18,007
Erythema	352		
Herpes	572		

[a] Unless otherwise stated, all figures for the World War period are derived from sick and wounded reports sent to the Surgeon General.—*Ed.*

An analysis of the above tabulations shows the relative importance of scabies among the skin infections. It also shows that, with the exception of scabies, there was a preponderance of diseases of the skin among our forces in the United States. This is doubtless due to the fact that not only were skin diseases affecting inducted men charged to the United States rates, but also skin diseases acquired by members of the American Expeditionary Forces and discovered after the return of these forces to the United States. It is very unfortunate that the tabulations can not reveal the true state of ectoparasitism and its relationship with secondary infections of the skin. In so far as pediculosis is concerned estimates only can be made of its prevalence, for men who were lice infested were not admitted to sick report for purposes of disinfestation, but disinfestation was practiced as a routine, particularly among our field forces. As an instance of the extent of pediculosis among our forces, it may be said that at about the time the armistice began it was estimated that among our combat divisions at the front the lice infestation rate was fully 90 per cent.[2]

In the Army in both the United States and France dermatology was combined with urology. Thus, in the Surgeon General's Office there was a section of the division of infectious diseases and laboratories devoted to urology and dermatology. Specialists in these subjects were assigned to each camp and large hospital. In the American Expeditionary Forces also these specialties were combined. In the division of urology and diseases of the skin there were a senior consultant, a consultant in urology, and two consultants in dermatology; a consultant in urology for the base sections; a urologist for each combat division, for each base section and hospital center.

In the United States, wards occasionally were set aside solely for the treatment of skin diseases. Thus a distinct dermatological service was established at the base hospital, Camp Pike, Ark., in the summer of 1918.[3] Also a special ward was established at the embarkation hospital, Newport News, Va., for the treatment of infectious skin conditions.[4] On the whole, however, patients with skin diseases were treated either in the general wards or in the venereal-disease wards. In the American Expeditionary Forces also the rule was to treat patients with diseases of the skin in either general or venereal wards. There were exceptions to the rule. During the spring and summer of 1918 it was possible for some of the field hospitals attached to combat divisions to operate as skin hospitals. The 42d Division, for example, operated such a hospital while in the Baccarat sector, from the latter part of April to the latter part of June.[5] Such hospitals, however, could be temporary expedients only, and were perforce discontinued when open warfare was begun in the latter part of the summer.

In the district of Paris, American Red Cross Military Hospital No. 9 was utilized largely for the treatment of skin diseases.[6] It was originally a Russian bath establishment containing 60 bathtubs, and had accommodations for approximately 100 patients with skin diseases in addition to those in the genitourinary department. This was the only permanent military hospital in the American Expeditionary Forces that was utilized almost solely for the treatment of skin diseases, and base hospitals cared for such conditions in much the same manner as was done in hospitals in the United States.

From what has been considered above it is seen that, of all the skin diseases, the Army was most concerned with scabies and pediculosis; also that though there was considerable pediculosis among the troops, more especially the American Expeditionary Forces, there was a relatively small amount of secondary skin infection attributable to pediculi.

SCABIES

In view of the fact that scabies was so well known prior to the war, the question may well be asked why this disease is controlled with such difficulty in the Army. The answer is principally in the matter of diagnosis. In civil practice when the date of a single known exposure can be obtained, several weeks usually elapse before the patient notices any marked itching, or seeks medical advice. Under army conditions, particulary when men are forced to go without change of clothing for prolonged periods, as under conditions at the front, the incubation period is doubtless shorter than in civil life.

n Chart LII, which shows the rate per thousand strength of scabies, both for white and colored enlisted men in the Army in the United States, some idea may be obtained as to the amount of scabies to be anticipated among inducted men. Prior to the World War, the incidence of scabies in the Army was 1.50 per thousand per annum. In the fall of 1917, however, after the mobilization of the new army had begun, the rate increased to an average of 3 per thousand per annum. During the greater part of the following year this rate varied between 3 and 4 per thousand per annum for white enlisted men, and for colored enlisted men it was below 2 per thousand except during the month of May, 1918. As to the reason for the comparative freedom of the colored enlisted men from scabies in our cantonments in the United States during 1917 and the greater part of 1918, or until the time when overseas men began to return to this country there is some question. It is not believed that the colored person enjoys any proportionately greater freedom from infestation by the itch mite than the white man; doubtless, being less hyperesthetic than the white man, he experiences less itching. Thus, there are less scratching and, consequently, less secondary infections of the skin. It is possible in this way to account for relatively fewer colored men seeking medical advice as to scabies; furthermore, many cases of scabies among the colored men are missed through difficulty in recognizing the condition.

Chart LIII shows the cumulative effect of front-line service on the existence of scabies; that is, as more and more of our combat divisions entered the front line the rate for white enlisted men, who mostly were concerned, rose from 7.67 per thousand per annum in March, 1918, to 14.23 in August. For September, October, and November following, the rates apparently decreased. This decrease was more apparent than real, however, for it was during these months that our troops were most actively engaged in battle; there were fewer opportunities for physical inspection of the men than ordinarily was the case; furthermore, many men with scabies, thinking themselves lice infested, failed to seek medical advice on their own initiative. On the other hand, the true situation as regards scabies among the combat troops is reflected in the rates for this

disease during the month of December, 1918, and in 1919. It was possible now to examine physically all members of the overseas forces. In fact, intensive efforts were made to eliminate all ectoparasites. Thus, in the conduct of the physical examination an essential part of the disinfestation process, it became possible to recognize a measurably greater number of cases of scabies.

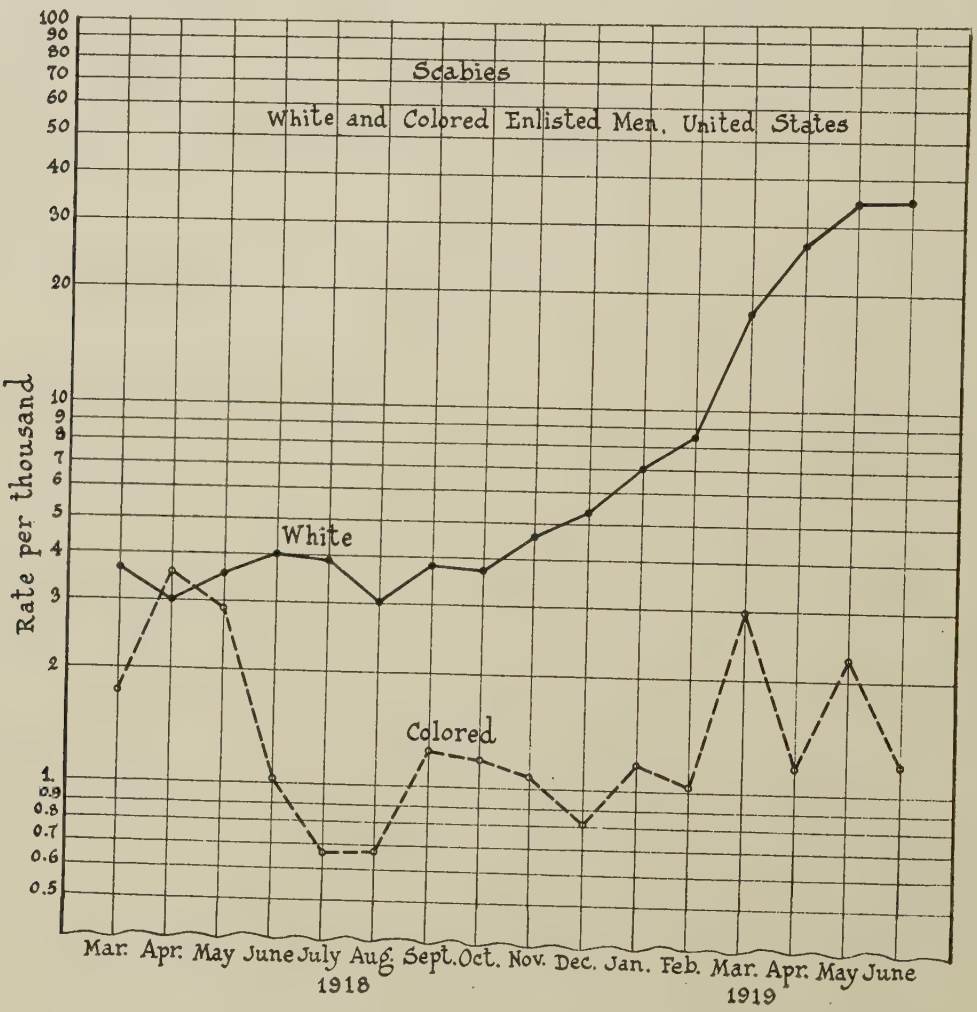

CHART LII

As to the mode of spread of scabies, it has been observed that the incidence of scabies greatly increases in the civil population during wars. Though in civil life scabies is usually contracted by sleeping with an infested person, in military life the use of infested blankets is doubtless a common mode of transmission. Other articles of wearing apparel, not ordinarily suspected, may become infested and may transmit scabies. Munro,[7] of the British Army, showed that gloves which aviators used in common could easily transmit the disease.

DIAGNOSIS

The scabies that occurred in the Army, particularly among our overseas forces, differed materially from the scabies of civil life. The burrows were not so characteristically located; itching at night was not commonly complained of; the condition frequently was veiled by pyodermias or the superimposition of lesions due to pediculosis. Burrows between the fingers and on the palms seldom were present; however, vesicles were common there, and on the penis,

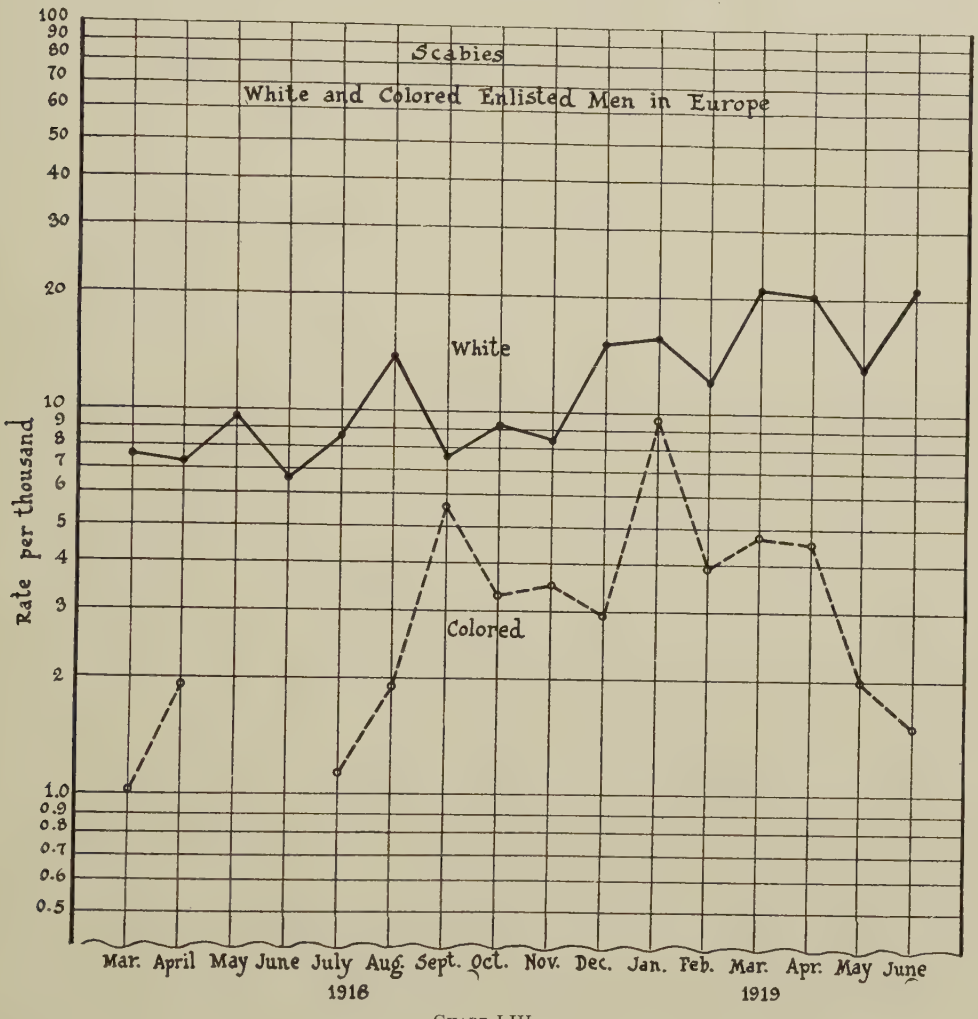

CHART LIII

papules, vesicles, and crusts usually were present. Thus, because pediculi do not attack these regions, the presence of lesions there was of great diagnostic value. Impetiginous crusting of the skin over the elbows, knees, and buttocks being practically pathognomonic of scabies, also was of diagnostic value. Other favored sites for the excoriated lesions were on the flexor surfaces of the wrists, the anterior folds of the axillæ, the abdomen, and the inner surfaces of the thighs.

TREATMENT

The object of the treatment of uncomplicated cases of scabies was to expose the itch mites and their larvæ and then to subject them to an insecticide. Of the several insecticides of reputed value in the cure of scabies medical officers placed almost sole reliance on sulphur in ointment form.

Before the ointment was applied it was necessary for the patient to take a hot bath, using plenty of green soap applied with a bath mit. A tub bath was preferable, but since tub baths were rarely available, particularly in the American Expeditionary Forces, hot showers were used. The length of time given to the bath varied from 20 to 30 minutes, usually the latter. The bathing was arranged as follows: The showers, arranged in batteries of heads, so that groups of 36 or more men could bathe at once, were turned on for five minutes. Each man then lathered himself thoroughly with green soap. The water was turned off, and the men so arranged themselves that each could scrub the back and buttocks of the man in front. A bath mit made of Turkish toweling was usually used for this purpose, though occasionally nailbrushes were used. Five minutes were devoted to this part of the scrubbing; then for 10 minutes each man scrubbed the remainder of his own body. The showers were now turned on, and for 10 minutes the men stood beneath them and removed all soap. After thoroughly drying themselves the men applied sulphur ointment to their bodies, from their necks to the tips of their toes and fingers. To facilitate the application of the ointment to their backs, the men formed a ring so that each could apply the ointment to the man in front, in much the same manner as the scrubbing with soap was accomplished. Five minutes were given up to this. For the next 15 minutes each man applied the ointment to the remainder of his own body.

The ointment was allowed to remain on the body until the following day, when the bath, as described above, was repeated. On the third day a cleansing shower was given but no ointment was applied.

In the American Red Cross Hospital No. 9, in Paris, the sulphur rub was repeated on three successive days. In a series of 300 cases treated there the relapses numbered 3, and there were but 3 cases of sulphur dermatitis.

In cases complicated by pyodermia it was necessary first to cure the complication before the severe method of treatment outlined above could be given. Meanwhile, the scabies could be kept in abeyance by the application of a 10 per cent sulphur ointment.

As regards the length of time required for treatment, we have seen that in uncomplicated cases this was from three to four days. In complicated cases, however, the average stay in hospital was a month.

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CHAPTER XXI

NEUROCIRCULATORY ASTHENIA

Shortness of breath and cardiac palpitation, tachycardia, pain in the region of the heart, and unstable neurovascular reflexes constitute a syndrome to which various names have been given. The term "neurocirculatory asthenia" was accepted for it by the Surgeon General in 1918.[1] There can be little doubt but that the symptomology is best described under this name. MacFarlane[2] proposed the name "Neurocirculatory myasthenia," which possesses all the disadvantages of the official term without being so inclusively correct. While the "effort syndrome" described by Lewis[3] may conform to the type of the syndrome recognized by British observers, it falls far short of describing the form chiefly seen by us, in which the condition was usually well established before any unusual military effort had been demanded. The still more unsatisfactory term of "disordered action of the heart," briefly known, after the British manner, as "D. A. H.," long held its own in the British service, but it is extremely inadequate in every respect.

The term "irritable heart," originally proposed by Da Costa,[4] is perhaps the best of the shorter names applied to the condition. This, however, definitely suggests that the disorder is essentially a cardiac one, which it certainly is not, and the further modification of this term, "the irritable heart of the soldier," is even less desirable, since the condition occurs alike in civil and military life, except that the complex becomes most apparent and perhaps most disabling under military requirements.

Many other terms, variously applied to the condition, the "nervous heart," the "hyperthyroid heart," "shell-shock heart," and the like, are most unsatisfactory, in so far as defining the condition is concerned. Unfortunately, before and during the World War the condition was reported under all sorts of headings, depending very largely on the degree of misunderstanding of the condition which existed in the mind of the author. This so confused the classification of the subject that it is quite impossible to judge adequately as to the rate of occurrence of the syndrome, since so much depends on the classification adopted by each particular writer. Even after the term "neurocirculatory asthenia" had been officially adopted by the Surgeon General incorrect recognition made it impossible to form a correct appraisal of the universal occurrence of the condition. The unfortunate failure of most authors of textbooks on medicine to recognize the condition at all resulted in a very inadequate appreciation, in both civil and military practice, of the importance of the syndrome.

PRE-WAR OCCURRENCE

Most of the early references to the condition now known as neurocirculatory asthenia are to be found in American literature, especially in that based on experiences during the Civil War. Thus, in the official Medical Department history of that conflict one finds the following important statement under the initial heading of "Functional disturbances":[5] "Among the affections of the

heart a functional disturbance known by the name of *irritable heart or cardiac muscular exhaustion* was the most notable production of the war." Da Costa studied a series of 300 cases of this disease in his hospital at Turners Lane, Philadelphia, whither cases of this condition were referred for his observation.[4] Smiley found that cases of this type which he studied at Hilton Head, S. C., occurred chiefly in every young man of feeble constitution, probably taxed beyond their strength.[6,7] McKelway [6] said of the condition as it appeared during the Battle of Williamsburg: "Disease of the heart appears to have been developed in several cases from overexertion preceding the battle and excitement and effort during its continuance." The text of the history [5] goes on with the statement that "Overaction of the heart during an engagement was due perhaps as much to nervous excitement and anticipation of danger as to overexertion."

Hunt is quoted as saying concerning the name "irritable heart"[7]: "The term is a misnomer; yet, as I have already shown, it was employed in 1,200 certificates of disability. In all cases the objectionable phrase described a heart far too rapid in its action, the pulse ranging from 120 to 150, frequently attended by dyspnœa, vertigo, or syncope, but revealing no abnormal sounds either on percussion or auscultation. The convenience of this collocation of words was perhaps the strongest reason for its employment. It saved an extended historical notice of each case upon the limited space of the certificate of disability. In reality these were cases of disturbance of the function of the heart dependent upon causes foreign to the organ itself."

A full recognition of the condition as distinct from that of dilatation of the heart is shown also in the reference to the work of Surg. M. K. Taylor, United States Volunteers, who made a special study of dilatation of the heart, incident to military service, in the hospitals at Keokuk, Iowa.[7 8]

Nothing better has ever been written concerning the subject than the contributions by Da Costa,[4] Hartshorne,[5 9] and of Stillé,[10] all names since famous in American medicine. None of the studies originating from the World War have added materially to the clinical description furnished by them. Only the advance of medical science as a whole has contributed viewpoints essentially improving or modifying the understanding of the condition as expressed by these observers. The heart sounds and murmurs which occur in this syndrome have never been so accurately or graphically described as by Da Costa, so that nothing further need be said of them. The essentials of successful treatment are also outlined in this remarkable contribution as definitely as in any of the more recent studies of the syndrome.

Furbinger [11] mentions the occurrence of a similar condition in the German Army in the campaigns of 1870–71, and Wilson [12] calls attention to the fact that in 1864 the British Government appointed a committee to investigate the subject, and particularly the relationship which the equipment of the soldier might bear to its occurrence. This last subject had been already carefully considered by the medical officers of our own Army in the War of the Rebellion. White [13] goes so far as to state that the condition was old as the study of medicine, and that it was described by Hippocrates, Galen, and other ancient masters.

OCCURRENCE IN THE WORLD WAR

The great importance of the subject as it appeared among our recruits was very early apparent, as indicated by the numerous communications and articles which immediately began to appear from almost all mobilization centers. It is very regrettable that professional unfamiliarity with our own military medical history led to so much loss of time and effort before an adequate understanding of the subject was reached by the average medical officer.

During the entire period of the World War, neurocirculatory asthenia was one of the most frequent causes of rejection and of disability. The degree to which this was true can not be appreciated adequately from statistics collected by the Surgeon General's Office, due largely to the diversity of diagnosis of the condition in the early stages of mobilization, noted above, and the lack of proper classification. Even after the disease was fairly well recognized by medical officers, it was so infrequently grouped under the single term, neurocirculatory asthenia, until well into 1918, that the available statistics for the Army as a whole give but a very meager picture of the problem during mobilization.

Musser,[14] after a study of 424 cases of tachycardia from the 38th Division, classified these cases, etiologically, as myocardial, 69 cases; hyperthyroid, 9 cases; neurotic, 180 cases; nervous (emotional), 28 cases, and toxic, 36 cases. This probably gives a fair estimate of the relative occurrence in most divisions in which the condition was carefully studied by competent medical officers. No valuable estimate of occurrence in draft boards and mobilization recruiting stations is available. It was certainly very great.

AGE

The syndrome is notably one of youth and early adult life. Its appearance has been noted in children, usually in the offspring of nervously defective parents,[15] but it is most notable in about the years of military service. Ceconi[16] found in the Italian troops that most cases occurred between 19 and 25, a few were observed over 25, but none over 30. This corresponds pretty closely with the writer's observations, except that in groups of older soldiers, for the greater part officers of the various corps, frequent cases were found over 30 years of age. In civil life it occurs in much older persons, though still most prevalent and disabling in the late teens and early twenties. This fact admits of the simple explanation that in civil life by the time individuals reach 30 years of age they have either succumbed to some disease condition, to which these persons are particularly prone, such as the infections, or they have adjusted their conditions of life to their physical capabilities to such a degree that they are able to carry on fairly effectually. Under such favorable conditions many cases go on to substantial cure, and even when submitted finally to the rigors of military life, as was the case with many reserve officers and volunteers, they were then able to hold the symptomatic picture in abeyance.

Every practitioner who has carefully studied the condition in civil life recognizes that it is quite as frequent here as in the Army, though less apparent, usually because of the greater possibilities of adaptation permissible under civil as compared with military conditions. This observation was emphasized

56706—28——36

by Neuhoff.[17] Schlesinger,[18] on the other hand, from his experience in a cardiac hospital near the front, believed that he could show a lower occurrence of real cardiac disease in the Army and a proportionately higher appearance of the nervous forms. Fully one-fourth of this class of cases, however, had suffered from the condition prior to mobilization. The writer's own experience led him to feel that the occurrence in the Army was precisely similar to that in civil life except that the rigors and restrictions of military life often caused the syndrome to become apparent, where it might have remained in abeyance under civil conditions.

SEX

As a military disease the complex is naturally seen mostly among men. This is due to the fact that women in the military personnel are so relatively few in number, and, to some degree, because certain of the dominant traits of the complex, while always noteworthy in men, would hardly be remarked in women, in whom one accepts certain emotional instabilities as normal feminine reactions. In nurses and other groups of women engaged in the more stressful theaters of warfare, as in mobile operating units, evacuation hospitals, shock and operating teams, and the like, the occurrence of the complex appeared to be about the same as in men. In civil life the writer's observations have led him to feel that sex in itself plays no real rôle in the determination of occurrence especially when women are subjected to the same rigors of life demanded of men, which in all instances cause the disease to become most apparent.

RACE

As observed at Camp Upton, N. Y., during the mobilization of the 77th Division, there was a very definite racial influence apparent in the occurrence of the disease. From a special study of this racial influence at Camp Upton, it was found that the syndrome occurred far more frequently among the Hebrews, notably among the Russian Jews, than among other races. Next in occurrence came those of Italian birth or origin, then the Irish, the Americans, the English, Scotch, German, and, last of all in point of frequency of occurrence, the negro. In an entire brigade of negro troops mobilized at Camp Upton and largely selected from the adjacent territory, but augmented by several small contingents from the Southwest, but one case of clearly defined neurocirculatory asthenia presented itself at the base hospital during the writer's service there. Cases were seen by him in the field hospitals operating with the 92d Division in France, but they were definitely less in number than developed among usual white troops. The complex would then appear to bear a very definite relationship to the emotional status of the various peoples. Roughly speaking, one may say that the greater the emotional status of a people, the higher will be found the occurrence of neurocirculatory asthenia. It has been said that it is also a disease of the intellectual as compared to the physical types; and while to a certain extent study of large groups appears to bear this out, it will be found much nearer the truth to make such a distinction on an emotional rather than an intellectual basis.

HEREDITY

Hereditary influences are definitely traceable in most instances. Conner,[19] in his analysis of cases rejected for cardiac defects, mentions the not well-recognized fact that constitutionally inferior recruits suffered mostly from this complex. The relationship of this status to hereditary influences is fully established. Clerc and Aimé [20] [21] emphasized constitutional predisposition. Oppenheimer and Rothschild [22] stated positively that there is a definite family history of factors predisposing to the psychoneuroses in most cases. They particularly urged the importance of a fundamental inferiority in the development of the complex. Robey and Boaz [23] were of like opinion. While the establishment of this important fact was often very difficult in the stress of mobilization and military activity, the writer has been amply able, from a study of the condition in civil life, to completely establish heredity as a very important determining factor. One or both parents show, usually, traits of nervous or endocrine instability of one sort or another. They may be hysterical, hyperthyroids, neurasthenics, hypertensives, insane, or they may, like their offspring, show the manifestations of the complex itself. A definitely obvious hereditary influence of instability of some sort is almost always obtainable of the nervous, endocrine, or circulatory systems.

GEOGRAPHICAL DISTRIBUTION

Study of the statistics from the Surgeon General's Office throws no apparent light on this question, but the syndrome appears to be more frequent in urban as compared with rural populations, and of course the racial influences already mentioned play a rôle in the geographical distribution.

INFLUENCE OF OCCUPATION ON OCCURRENCE

One might not unhappily reverse this heading and state, better, the influence of this syndrome on the selection of occupation. Almost without notable exception successful men suffering from neurocirculatory asthenia are found in the ranks of mental in contradistinction to physical occupations. Marshall [24] called attention to the fact that nearly all cases had neglected athletic training and had followed sedentary occupations, as the writer believes through necessity rather than through choice. As a rule it will be found also that when persons suffering from this condition are engaged in laborious occupations they are failures to a greater or lesser degree. On the contrary, many of them stand very high in the professions and in occupations in which dominant mental or emotional characteristics are qualifying rather than otherwise. This was particularly manifest in the National Army draft. In divisions, for example, the percentage of cases found among bandsmen was much higher than in the infantry or mounted forces. The same status was noted in most of the allied forces. Thus Thomas [25] reports as follows on 1,000 cases under his observation: "Light work, 25.6 per cent; work in open air, 20 per cent; sedentary occupations, 17.8 per cent; heavy industrial work, 15.2 per cent; light industrial work, 12.5 per cent; Army and marine, 5.5 per cent; undetermined, 2 per cent." In civil life the very frequent occurrence among successful musicians, artists, actors, writers, and similar classes is striking and to a very convincing

degree emphasizes the association of the complex with emotional activity. For the most part those engaged in physical occupations found to be afflicted with the status were almost without exception inferior or ineffective workmen. Where it was possible in the assignment of soldiers to take cognizance of these tendencies, often men entirely unable to undergo the stress of real military work were found to be very efficient as clerks, signal men, bandsmen, and the like. In all armies it was soon found that a large number of soldiers who were unable to carry on in line duties were most effectively employed in positions in the rear, as in the Services of Supply. This selective tendency has been manifest in sports. As a general rule, in both military and civil classes, it is found that few of these individuals are found, as, for example, in colleges, on football or baseball teams. On the contrary, as a class subjects of this condition, through obligation or by selection, elect sports demanding more emotional and temperamental, rather than physical, prowess. While unable as a class to endure prolonged physical stress, some excellent tennis players, golfers, and the like must be included as belonging to this classification.

RELATION OF OCCURRENCE TO MALINGERING, "CONSCIENTIOUS," AND OTHER "OBJECTORS," AND TO COWARDICE

Neurocirulatory asthenia is manifestly a disease of the emotionally unstable. It is to be expected, therefore, that it would be found associated more, rather than less, frequently with mental and moral aberrations. To a certain degree this has been found to be the case. In the writer's observation it has shown little or no relation to malingering. Malingering is a condition certainly associated with definite tendencies, and it is no more frequent among those suffering from this disease than in any other class, social or physical. Conscientious objectors present a quite different question. Inasmuch as this class of genus hominis can be divided roughly into those more or less mentally or morally defective and those of a criminal type, it will be thought natural that in the first classification more than an ordinary percentage of endocrine aberrations will appear from the close association of neurocirculatory asthenia to such disorders. Our observations at Camp Upton amply substantiated this surmise in so far as those who based their lack of willingness for service on real religious belief or on emotionally based theories of other varieties. This was notably true of hyperthyroid types that constituted a high percentage of enthusiasts of all varieties. As to the more frequent criminal type of "objector," no particular relationship to the complex appears to exist. Evasion of service was naturally attempted by some individuals suffering from neurocirculatory asthenia; but, in so far as the writer's observation goes, fully two sufferers from this disorder were attempting subterfuge to enter the service to one who was attempting to evade it. While doubtless frequently of an emotionally unstable character, cowardice was by no means notable among neurocirculatory asthenics, and decorations for particularly courageous service were awarded in several instances in the writer's observation to outspoken examples of this disorder.

ETIOLOGY

After the economic and military features, the chief interest in the syndrome centers about the question as to its real nature and etiology. It is notable that very little interest has been excited up to date among purely civil practitioners in regard to the syndrome. It has been rated and described almost exclusively as appearing under conditions of military activity. It is very obvious that the condition appears as a dominant problem only under conditions of mobilization, or of great emotional stress. It seems fair, then, to assume primarily that emotional stress and excitement bear an important rôle in the evolution of the complex, notwithstanding its great civil occurrence.

One of the most striking features which was apparent to every student of this condition in the United States was the marked difference in the conditions under which these cases developed in the camps of mobilization in this country, as compared to the published accounts of the conditions, particularly as they appeared in British literature. In so far as one may judge from the British accounts, cases of the syndrome appeared practically only, or certainly most frequently, in men after the stress of battle experience. In this country, in practically all of the mobilization camps, it was found as a very frequent condition in recruits who had had no real military experience whatever. They came to the camps with the complex well developed, and the war in itself could have had no possible bearing on the condition, unless it be through the highly emotional tension which prevailed in our society at large during those times.

Perhaps to a considerable degree this emotional tension was a result of the excitement and emotional cataclysm which attended enrollment and departure from home to the training camps. Large numbers of these men were found at the very first examination to be entirely unfitted for military service of any kind, and were forthwith discharged or sent to the base hospitals for treatment and observation. Clinically these cases, none the less, completely resembled those which developed under the stress of service, except that the British reported almost unanimously that rest gave great relief in their cases which had developed under heavy service conditions, while in our cases little or no improvement took place under rest treatment in the mobilization areas. Observation later on of our cases which also broke under the stress of active war operations proved abundantly that the British observations were entirely correct, but that these cases represented minor or undeveloped degrees which broke under military stress, while cases which manifested the disease before any real service had been performed, though essentially of the same variety, represented the most active, constant, and incurable phases of the condition.

A sharp distinction in degree must then be made between cases which appeared so numerously in our mobilization camps and those which subsequently appeared in men who had stood reasonably well the strain of mobilization but who broke under battle stress. Between these two classes lies another smaller group which broke under the weight of military training. Many or most of these men were able to carry on in a very satisfactory manner if transferred to less arduous duties, as to the band, to clerkships, or to domestic quartermaster duty. Some who had borne the stress of training poorly as enlisted men were able to get on very well as noncommissioned and commissioned officers.

It must not be supposed from this statement that the condition was unfamiliar in the commissioned personnel. It is the writer's observation that it was relatively quite as frequent among officers as among enlisted men, and the number who eventually broke was probably relatively as large, though perhaps not quite so manifest because of the class pride which caused the officer to fight off the tendencies perhaps with more determination than was exercised by the average enlisted man. During the period of collapse there was no essential difference between the various types of the disease where it developed as a result of battle service, or was manifest on enlistment. The former, however, offered a much better prognosis as to ultimate result. Some of the cases which developed under the sudden weight of training were able to recover and finally to return to satisfactory but more gradual training. This was especially true of persons who had been taken suddenly from sedentary pursuits to be placed at once under the severe physical exactions of military training.

Throughout it was noted that the emotional type of recruit was that which suffered most acutely. Phlegmatic men were far less prone to break, and yet it must be conceded that it is from the former class that many of the best soldiers were developed. Somewhat similar epidemic forms of the complex become manifest, for example, in schools and colleges at the time of examinations and the like. The disease is definitely not a military one, then, but one which becomes only more numerically manifest during war, because of the selective character of military service and of the existing conditions which now become necessarily more insistent than is the case under mere civil life.

Certain observers, among them Lewis,[3] pointed attention to the probable rôle of the infections in the genesis of the condition. It can not be disputed that infections which, among many other factors, lower the resistance of the body against any pathological process may act as an exciting or precipitating factor, but it is extremely improbable that they have any direct etiological rôle in the development of the condition. Briscoe and Diamond[26] conducted a series of experiments to determine if bacteriemia was present, but met with negative results. There is no definite evidence in favor of this theory except the frequent associated occurrence of the infections with the disease. It is conceded, however, by most writers that the existence of the syndrome greatly lowers resistance against infections, and the observation of the writer corroborates the almost universally conceded point that patients with this disease have a much lowered resistance against certain specific infectious processes, as tuberculosis.

Musser[14] pointed out that soldiers who had been gassed were particularly prone to develop neurocirculatory asthenia, and a great many other similar factors, undoubtedly also through lowering of general resistance or through abnormal production of exhaustion, act similarly. Forced marches, heavy firing, and the general commotion and unrest of the front, as pointed out by Thomas,[25] are also undoubted predisposing but not causative factors. Attention has long been directed to the possibility of predisposition being excited by unaccustomed physical effort with the production of severe degrees of exhaustion. During the Civil War and again in the World War, attention was directed to the possibility of uncomfortable uniforms, too heavy and improperly adjusted

equipment, and the like, being factors in the induction of the syndrome, but again these must be considered as predisposing and not elementally etiological factors.

Tedeschi,[27] among others, has drawn attention to the well-accepted fact that digestive disturbances induced either by unaccustomed or improperly prepared food, might be a factor of inductive nature. Clerc and Aimé (P)[21] mention the effects of the excessive use of tobacco and of alcohol in the production of the disease. Merkel[28] even states that it was found more frequently among Bavarian than among Prussian troops because of the larger amounts of beer consumed by the former. Our observations at Camp Upton showed that the syndrome occurred quite as frequently among nonsmokers as among those who use tobacco. Marshall[24] also coincides in this observation. It is, none the less, the impression of the writer that the abuse of tobacco does exaggerate the symptom complex, notably the tachycardia. Many observers, however, dissent on this point. Tea and coffee, with even less basis, have been urged as important etiological factors.

A relationship between previous cardiac disease and neurocirculatory asthenia has been noted by some authors, but in most instances reference to previous cardiac disturbances rather than to definite cardiac lesions is cited. The relatively frequent occurrence of the syndrome in myocarditis, myocardial degeneration, and adhesive pericarditis has been cited occasionally, but the number of cases in which these anatomical lesions have been found associated with the complex is very small, as is well illustrated by the exceedingly low death rate in the syndrome. Certainly most cases of definite organic disease of the heart had been eliminated in the selection of soldiers, and the association of the syndrome with the development of organic heart disease is so relatively low as to be unimportant and to quite definitely serve to class this syndrome as no instance of cardiac disease. This point was apparently definitely decided in the Civil War, but it is continually being revived. It must be admitted, however, that these cases have a lowered cardiac reserve, just as they have also a lowered muscular, nervous, mental, and general physical reserve.

Many observers, among them the writer, have called attention to the association of the disease with thyroid instability, or definitely with hyperthyroid activity. Certain cases are so dominated by the symptoms of hyperthyroid activity that it is very easy to fall into the error, as the writer originally did, that hyperthyroidism is an etiologic necessity in the syndrome. Among those who have stressed this relation are Lian,[29] Caro,[30] Aschenheim,[31] Ehret,[32] and Sir James Barr.[33] The writer believes that hyperthyroid activity is an essential part of the syndrome in many instances, as is indicated by the very frequent occurrence of hyperthyroid symptoms in the cases, but he no longer feels that this relationship is etiologic or universal. Sturgis, Wearn, and Tompkins,[34] reported an increased metabolic rate in many of these cases and stated that the Goetch reaction is presented by them with considerable frequency. Spiller,[35] appeared to feel that hyperthyroid activity, probably in association with other endocrine disorders, plays an important rôle in the complex, perhaps through fixation of blood salts, as proposed by Lewis and his coworkers.[3 36 37]

The similarity of many of the manifestations of the conditions to some of the types of thymus disease has already been pointed out by the writer. Evidence of adrenal disturbances has been remarked by many observers, There can be no doubt but that profound instability and incoordination of action of the various endocrines is present in the disease. The preponderance of evidences of thyroid instability is the most striking of all, but at present appears to be but a part, not the sole, etiological factor concerned in the production of neurocirculatory asthenia.

Very closely allied to the last mentioned factors is the striking relationship of the sufferers from this complex to early exhaustion, both physical and nervous, and particularly to a combination of these with emotional exhaustion. The close relationship of the whole to "shell shock" is another bit of evidence pointing in the same direction. His [38] pointed out its close similarity to the traumatic neuroses. Excitability of the sympathetic system, lowered threshold of sympathetic stimulation response (MacIlwain[39]), all closely allied to endocrine fault, have been cited as of primary bearing in the complex. Various theories relative to the fixation of the salts of the blood, notably of the calcium, have been propounded, but these lack both adequate laboratory and clinical substantiation.

Undoubtedly the theory as to basic etiology which has best stood the test of study is that originally proposed by Oppenheimer and Rothschild,[22] who asserted that the complex is certainly not a disease entity. They found that in half the cases there was a family and previous history of factors predisposing to the psychoneuroses, and in almost 70 per cent of these there was a history of constitutional asthenia. They pointed out that normal individuals when they break down under the complex present symptoms chiefly of exhaustion; the relatively inferior individuals show both excitation and exhaustion. Oppenheimer and Rothschild then particularly stressed the importance of a fundamental inferiority in which doubtless endocrine imballance or inadequacy play an important determining part.

Given this primary tendency, under emotional and physical strain such as is exacted particularly under battle stress, loss of sleep, responsibility, prolonged shell fire, and the numerous other similar conditions which the soldier must meet, individuals showing perhaps but minor inferiority initially, break and develop the complex. Other soldiers, who primarily represent a greater grade of fundamental inferiority, especially in their endocrine and general physical make up, fail under much less stress. If their primary defect be sufficiently marked, under stress well borne by the normal individual, they fail and may present the characteristic clinical picture of neurocirculatory asthenia.

Although the writer agrees in the main with the assumption that we are not dealing with a disease entity in neurocirculatory asthenia, it seems certain that we are concerned with a fairly well-defined and readily recognized clinical condition based, not on a definite pathology perhaps, but on a chemical fault or status founded on a congenital defect in pronounced cases and developed in less marked instances by exhaustive chemical conditions which have definitely to do with the endocrine system.

THE PHYSICAL TYPE

The physical appearance of these men is quite characteristic in all fully developed instances, in most of which it is in itself conclusively diagnostic.

The syndrome occurs in two chief types of figure. In the one the patient is tall and slender, very likely to be stooped somewhat in posture. The thorax is narrow, long, and rounded in cross section. Lumbar lordosis is frequent. The pelvic girdle is notably narrow. The extremities are long and slender; usually the muscles are soft and flabby and very poorly defined in form. The extremities suggest the female rather than the typical male type. The hands and feet are long and slender. They are practically always cyanosed, cold, and sweating. The capillary return in the hands, feet, and face, notably in the nose and ears, is delayed. As a rule the skin is thin and soft. There is usually very little hair on the body and it is likely to be notably soft, silken, and curly, and the distribution is more of the female than of the usual male type. The external genitals are usually small and poorly formed.

The other type, which is far less frequent, is of coarse build. The trunk may be flat and broad, almost thin. The skin is very coarse and rough, covered with scanty, bristlelike hairs, again more female than male in type of distribution. The deposit of fat in this type is occasionally large, and sometimes the head, hands, and feet suggest an early acromegalic type. The distribution of fat is commonly small but occasionally this type may show a considerable deposit of loose, flabby adipose. Hernia is very common in both types. The thyroid gland is prominent in most cases and in some of either type a certain degree of exophthalmus is present. The facial expression is anxious and worried, but the lining of the face is not ordinarily deep or the attitude sinister.

PATHOLOGY

Little information is available on this phase of the subject. The disease is not in itself a fatal condition and, during the war, when death in these subjects occurred from concurrent or complicating conditions, the resulting material was not such as to permit of conclusive deductions in regard to the basic state itself. Furthermore, the pathologists were occupied with more pressing problems, so that undoubtedly the subject did not receive the amount of attention which it merits.

In so far as the writer has been able to find, no characteristic pathological lesions exist either generally or in any special organ in neurocirculatory asthenia. Note has already been made of the enlarged thyroid present in many instances, but histological examination in these cases has shown only the changes of a parenchymatous hyperplasia. In no instance was the goiter of the cystic variety.

Post-mortem examination of the heart showed no typical changes, though in the ordinary case the heart as a whole appeared to be hypoplastic rather than otherwise. Smith,[40] after a teleoroentographic study of the heart, considered that in instances which had persisted for a long time, the heart was smaller than normal. The long, narrow, or "drop" heart was not the predominating form, in his experience, and the small heart might vary in shape as much as in the normal. The smaller hearts were found in men whose musculature also

was below the normal. The cases studied, which developed the condition under service stress, showed silhouette measurements that were well within the range for area and volume. Where a persistent tachycardia develops, myocardials changes must appear eventually, notably fibrosis, fatty and parenchymatous degeneration. Notwithstanding the dominance of nervous and cerebral signs and symptoms in the disease, no actual lesions in the organs of the central nervous system appear to have been described.

RELATION TO OTHER DISEASE PROCESSES

Men suffering from this complex showed, in practically all respects, a lowered resistance against other disease processes, particularly the infectious diseases. So definitely was this evident that many observers considered neurocirculatory asthenia as caused either by a general or specific infection. The peculiar susceptibility of these men to the acute respiratory infections has been mentioned. This tendency appeared to exist particularly with regard to tuberculosis. There is a possibility of easy confusion of the condition with tuberculosis because the physical characteristics of the two conditions in some respects appear quite similar, but beyond this there is a very certain lack of resistance on the part of these men toward this infection.

They were also particularly prone to measles, scarlet fever, and mumps, unless protected by previous attacks, and it was notable in any organization that the first groups of men to succumb to these diseases were those who had the stigmata of this basic condition. General infections, as of wounds, also ran a more unfavorable course than should normally be the case. The same was true of surgical conditions. Wounded men of this type were found to recover less rapidly and they were also often prostrated by relatively minor traumatic conditions.

Japhs and Meakins[41] made a study of cases of irritable heart associated with amebic dysentery in troops returned from the British Mediterranean force. They found that treatment of the dysentery by salts of emetin also considerably improved the symptoms of irritable heart.

There is also a lowered resistance to many general diseases, especially toward those of endocrine origin, as Grave's disease, myxedema, Addison's disease, and diabetes mellitus. In several cases under our observation definite acromegalic stigmata developed. Susceptibility to trench foot, trench fever, nephritis, and similar diseases was noted by various observers. The general statement may be made that men suffering from this condition have a lowered resistance toward practically all disease conditions.

After what has been said, it appears unnecessary to point out that the physical endurance of these men is definitely subnormal, and no matter how determined or how well trained men might be, many of them broke under the stress of military service. This was particularly notable in certain officers of the Regular Establishment who were in all respects normal and well-prepared men, but who, having this complex as a basic state, failed in endurance when put to the severe test of military life as it existed in the war.

The frequency of fear complexes was notable and the exaggeration of emotional stimuli sometimes led men otherwise exceedingly well fitted for

military responsibility to become men of poor judgment, and with low grade powers of analysis. Recalling the elementary unstable mental and emotional tendencies of this type of man, it is entirely to be expected that they would furnish a high percentage of the cases of so-called shell shock and of war neuroses of all kinds. Once ideas of this kind become impressed on a subject of this complex, they are eradicated with much greater difficulty than would be the case in normal men. This tendency was found of particular import in the treatment of these cases in that if they had once been impressed with the idea that they were suffering from cardiac disease it was found extremely difficult, even with highly intelligent men, to disabuse them of the idea. The ease with which men of this type might be persuaded to the adoption of any theory of a serious condition was very striking as compared to the extreme difficulty with which any such phobia could be dislodged. Even courageous and determined men of this type of infirmity found themselves possessed often by periods of fright altogether out of proportion to the normal reaction called for in any emergency.

LABORATORY FINDINGS

The urine.—No detailed studies of the urine are available; in the cases under observation at Camp Upton nothing in any way characteristic was found. From studies of the urine made at the Hamstead Military Hospital it was found that the urine was hyperacid, and showed excess of phosphates and calcium oxalates, as in other neuroses.

The blood.—A deficiency in the buffer salts of the blood was advanced by Lewis and his coworkers as explanatory of the breathlessness observed in many cases.[36] This symptom, however, is unrelieved by the administration of the alkalies, and Adams and Sturgis [42] found a normal or combining capacity of the blood in their cases, concluding that the dyspnea was of neurotic type.

In a small group of unselected cases Levy [43] found that the red cell blood count was high. The average number of red cells was 5,837,000. One-third of the cases had a count of over 6,000,000, and more than one-half, a count of 5,900,000 or over. The hemoglobin percentage was for the most part below normal, the average reading being 93.4 per cent.

Leucocytosis of moderate degree, with usually more or less relative lymphocytosis, was found by Briscoe.[44] Gay's findings were similar, but he reported also a slight eosinophilia. Laubry and Esmein[45] reported a mononucleosis in 22 out of 30 persons suffering from the cardiac instability.

Blood pressure.—The blood pressure in the cases studied was lower, as a rule, than in most normal groups. Some cases, particularly when in a marked state of exhaustion, showed definite hypotension, but under emotional excitement the pressure varied much, but still well within normal limits.

Electrocardiography.—An electrocardiographic study of 12 cases was made by Peabody, Clough, Sturgis, Wearn, and Tompkins.[46] The most striking change reported was a slight decrease in the height of the T-wave. This was most marked in lead II. In individual cases other abnormalities were found, but they have probably little general significance.

Gastric test meal.—Musser [14] found that subjects of this complex showed a very definite increase in the total gastric acidity and in free hydrochloric acid,

as compared to normal controls. The figures, however, do not represent definitely pathological degrees of hyperacidity.

Aside from these relatively inconclusive studies, very little has as yet been done in the way of routine clinical laboratory work in connection with the complex, and it would appear that little of value is likely to result from this line of study.

SYMPTOMS AND SIGNS

CARDIAC DISTURBANCES

It is because of cardiac signs and symptoms that most cases appear for examination, and it is also because of these dominant manifestations that most cases become inadequate. Again, most of the suffering, in so far as actual physical distress is concerned, is due to cardiac disturbances, and much of the mental agony and apprehension is likewise caused by heart signs and symptoms.

Tachycardia is the most striking of the cardiac signs. It is also one of the most constant marks of the disease. It is developed typically under emotional stress, and while it may also appear in some instances under physical stimulus, especially in the exhausted type of case, in many instances it is diminished or slowed under mild physical exercise, such, for example, as the usual tests for cardiac muscle reserve.

Sturgis, Wearn, and Tompkins,[34] showed that in cases of irritable heart, after the injection of atropin there was a short preliminary drop in the pulse rate, followed, as in normal men, by an increase in pulse rate which was proportionately somewhat greater in the cases of neurocirculatory asthenia.

With the tachycardia in some cases, again particularly those of the exhausted type, arrythmia develops. As a rule, unless the case is complicated by some true anatomical cardiac lesion, this arrythmia is of the sinus variety, and it is in such instances probably unaccompanied by any real cardiac pathology, though in long-standing cases such may eventually develop. The subjective symptoms of cardiac disturbance, as a rule, are more dominant than the demonstrable signs. In general these may be included under the signs and symptoms of cardiac palpitation as described in the textbooks. A sense of distress or pain in the region of the heart is commonly complained of. Suffocation or pressure symptoms are located in the precordium.

Shortness of breath is the commonest of symptoms, but no true dyspnea is present except in severe instances of exhaustion or where some true lesion is present. This will be readily detected by subjecting the patient to temperate, physical exercise, which, in uncomplicated cases, either slows the rate or leaves it unchanged. On the other hand, emotional stress gives rise to marked accentuation of these symptoms, especially of the dyspnea. Often a considerable degree of physical exercise may be tolerated without any distress whatever. Occasionally the cardiac distress takes on the character of a sharp stabbing pain which may become so intense that the patient is forced to stop and to press firmly against the precordium with his hand.

In many instances a broad area of apical pulsation was noted, and in thin men one sometimes found also pulsations manifest in the intercostal spaces over the entire precordium. Schlesinger[18] states that marked irri-

tability of the pectoral muscles may be present. The soldier almost without exception complained bitterly of a sense of his own heart action. He was often able to count the rate, and to note any irregularities or modification of rhythm. Physical examination of the heart showed, as a rule, clear, sharp muscle tones, but in cases of great rapidity a blurring indistinctness of the tone was present. In instances in which great physical exhaustion was also present the character of the muscle tone was so indistinct that the diagnosis of a presumable myocardial degeneration seemed justified.

Various cardiac murmurs were often present, even in cases which subsequent study demonstrated to be free from either muscle or valve lesions. These murmurs were very inconstant in character, differing from moment to moment, modified after exercise, and oftentimes entirely removed by it, especially in numerous instances in which exercise steadied and slowed the action. The most frequent murmur was heard at the apex, was systolic in time, and was not transmitted from the point of greatest intensity. Soft blowing systolic murmurs at the second right interspace were common. Sometimes they were transmitted up into the carotid on the right side and frequently they were audible across the manubrium sterni, and at times were heard with maximum intensity in the left second interspace. After a study of the murmurs in cases of irritable heart, King[47] stated, correctly, that they have probably only accidental relationship to the basic condition. Exercise, as a rule, greatly modifies all these adventitious sounds, and often entirely obliterates them. Change of posture also usually effects some change or causes disappearance. Of course many instances are associated with all manner of circulatory lesions of a true organic character. In such, of course, there are present diagnostic signs of a character which often greatly confuses the recognition of neurocirculatory asthenia. Molle[48] called especial attention to the frequency with which venous femoral bruits are found in cases of the "soldiers' heart."

Blood pressure was found to be an extremely variable sign. Some observers state that it is usually elevated, others that it is low. The writer's experience has been that while it may be either, largely depending on concommitant or associated disease or temperamental conditions, in pure cases it is more commonly low, but under certain stimuli, particularly under mental stress or emotional excitement, it may become markedly elevated. In practically all instances blood pressure shows more variation than is usual in normal cases.

ARTERIAL TENSION

Laubry and LeConte,[49] from cases of cardiac instability studied in Professor Vaquez's service, delineated three groups according to their arterial pressure: (1) The unstable, which represents about two-thirds of the patients examined. Their tension varied from one day to another (2). The stable types, which presented a distinct fixation of tension. The variations from day to day were slight. (3) A small number of cases had abnormal arterial tension at first, but this usually became normal under the influence of rest and diet. They never found durable, permanent hypertension. Variation

in pressure was not especially marked in those with great cardiac instability or tachycardia. There was no relation between the degree of tachycardia and hypertension.

A striking sign occasionally present was the absence of a definable lower limit of diastolic pressure so that a condition of sphygmomanometry very similar to that seen in double aortic endocarditis was manifested. At times also a pulse very closely simulating that of the Corrigan or water-hammer variety was present. The tremendous effect which psychic factors produced on blood pressure was notable in most instances. A soft, irregular, at times a dicrotic, pulse may occur in any case and apparently without any essential anatomical disease.

FLUOROSCOPIC FINDINGS

Fleuroscopy of the heart often discovers extremely interesting data in the study of the syndrome. Wide, active contractures of the auricles, plainly visible on the screen, are the most striking of these findings. Occasionally ventricular hypertrophy is present, occasionally a true dilatation. In the typical uncomplicated case the size of the heart is not as a rule modified; more frequently than otherwise the heart, even in large individuals, is relatively small, long, and narrow, and often definitely of the hypoplastic type. As compared with the aortic arch, the heart often seems notably hypoplastic, for dilatation of the aorta seems to be present in a considerable number of cases. This anatomical finding, often not demonstrable post mortem, may account to some degree for many of the adventitious sounds, notably those heard at the base of the heart.

NEUROVASCULAR DISTURBANCES

Important as are the cardiac manifestations in the study of the problem, they are of but little more dominant character than the study of the other circulatory disturbances usually shown in the syndrome. Throughout and manifest in every certain instance of the syndrome is a very unstable neurovascular control. This is shown by marked dermographia, which is as striking, varied in type, and constant as in any group of cases of certain hyperthyroidism or goiter. The hands and feet are cold, usually cyanosed, though the cyanosis may at times be quickly followed, as in true Raynaud's disease, by a condition of waxlike ischemia. Cold sweat bathes the hands, feet, and frequently the entire body. Even when the surface of the skin is cold it may be covered with large globules of sweat.

These manifestations were notably emphasized when the soldier was under considerable excitement, as when undergoing an examination, considering discharge, or the like. Frequently the face was flushed, bright red in color, this being quickly succeeded by a wave of paleness associated with cold. Occasionally these dermal manifestations were accompanied by an intense but usually very transitory pruritus, commonly most marked over the anterior and lateral thorax and over the face. Other cases were associated with the formation of large wheals where the pressure of the clothing was marked or when slight blows were inflicted. Heat or cold may precipitate these lesions.

These striking evidences of neurovascular disturbance were often accompanied by certain nervous phenomena to be described elsewhere. This association seemed to indicate that probably similar vascular disturbances appear also in the deep viscera, thus explaining a large group of central signs and symptoms. Physical factors rarely precipitated these symptoms, though occasionally they would appear in their most exaggerated form after drill or otherwise when more or less physical exhaustion was also present. They were always most evident when cardiac disturbances were most annoying. They showed throughout a very definite association with emotional and nervous factors.

Very closely allied with these circulatory symptoms, and probably dependent on precisely identical factors, were certain urinary symptoms, such as are also commonly associated with such signs and symptoms appearing with like conditions in other diseases, as in various neuroses and in hyperthyroidism. The most striking of these was polyuria, which occurred during or immediately after the most violent attacks of tachycardia or syncope, or was associated with the dermal manifestations. This hypersecretion was apparently similar to that which appears in paroxysmal tachycardia. The urine so voided was commonly light in color and in weight. Tenesmus might follow or precede the voiding of the urine, which was ejected only with difficulty and with more or less pain, as though from contraction of the urethra. Small quantities only might be voided at a time, but the insistence of the desire was so imperative that complete urethral control was not always present. A good many of these cases showed enuresis nocturni.

ENDOCRINE SYMPTOMS

Endocrine symptoms and signs were dominant throughout all these cases, and the natural inclination of an observer familiar with this type of disease and not familiar with the syndrome itself was at once to class these men as of an endocrine dyscrasia, usually as instances of hyperthyroidism. The writer, early in his experience in the war, was also definitely of this belief, and reported his first group of cases under the heading, "Hyperthyroidism in the recruit."[50] The same error was made by many other observers, among whom are Caro,[30] Barr,[33] and Stoney.[51] While a close study of large groups of the syndrome, especially of the instances which developed in battle, is almost certain to eliminate this idea, in many respects it is rather well founded and one may well read into the interpretation of the disease many factors, signs, and symptoms definitely of an endocrine type. For the greater part these signs and symptoms may be best grouped under the heading of "Signs and symptoms of hyperthyroidism." In a considerable number of cases more or less goiter was present. Aschenheim[31] found it in 50 per cent of his cases. This was particularly evident in the cases which presented the well-developed syndrome on their induction into service, but it was much less definite in the instances which developed under the stress of service. Most cases will respond also to the so-called Goetsch test for hyperthyroidism. Peabody, Clough, Sturgis, Wearn, and Tompkins[46] found a positive response in 60 per cent of their cases, doubtful or suggestive in 10 per cent, and negative in 19 per cent. Notable also was the tremor of the hands; to a less frequent degree twitching of the face and tongue.

Dermographia was marked, and to a very large degree the mental attitude of these men was similar to that of those of mild hyperthyroidism. Again, there is a definite relationship to endocrine disorders in the heredity of the cases. Analysis of this element in the mobilization camp at Upton showed a very certain factor of this nature.[50] Careful study of large groups of the cases will, however, quite definitely indicate that though there are certain clear indications of endocrine defect or imbalance in neurocirculatory asthenia, it is not a pure thyroid problem.

SEX CHARACTERISTICS

Beginning, as this complex does, during the period of sex development, and extending, as it does, throughout the period of greatest sexual activity, it is quite natural to expect that these cases as a class early manifest certain sexual aberrations which appear to bear some definite relationship to the complex. A study concerning this phase of the subject was made by Goddard[52] at Camp Upton, N. Y., during the mobilization of the 77th Division. He found that a considerable percentage of well-marked cases of this disease had little or no normal sex instinct. Many had had no sex experience or desires, and a considerable number presented definite perversion or sex inversion. Most of them were rather indifferent to the normal sex call, and in most who were married sexual relations were apparently more based on sentiment and emotional proclivities than on a normal sex appetite. Development of the genitalia was found defective in a surprisingly large number of these men, and only a very few showed such dominant sex craving as is the rule among ordinary virile soldiers. A consideration of this phase of the question in civil life convinced the writer as to the accuracy of these studies. Observations of a similar trend were recorded by Aschenheim.[31]

Observations by the writer and by others in civil practice suggested that the capacity for fecundation is lower in those suffering from this tendency than among ordinary subjects. That this phase of the question bears a definite relation to other evidences of endocrine aberration so very manifest in this disease seems certain.

DIGESTIVE SYMPTOMS

Among the more prominent gastrointestinal aberrations which appear in the course of the disease, undoubtedly the most frequent and annoying is spontaneous attacks of diarrhea, which frequently mark the more violent attacks of the syndrome. These diarrheal attacks may be followed by short periods of constipation. Nearly all soldiers afflicted by the permanent form of this disease showed gaseous eructations to a greater or lesser degree. In most cases this symptom was accompanied by more or less swallowing of air. Occasionally acid eructations took place as in ordinary gastric hyperacidity. As a rule, cases which were investigated in this respect were found to show more or less gastric hyperacidity. Musser[14] verified this finding by his careful study. Borborygmi and annoying gaseous distention of the gut, especially of the colon, was present in some cases. The use of alkalies or washing of the lower bowel with an enema commonly gave temporary relief from these symptoms.

As a rule these men were poor and inadequate eaters, finicky and complaining about their diet. While most cases were in thin, rather malnourished men, there was another type of persons, who though not usually large eaters, were none the less obese. As a rule, sufferers from this complex were tall rather than short, slim rather than stout, undernourished rather than overnourished.

RESPIRATORY SYMPTOMS

Very few symptoms of the respiratory tract were manifested except those of rapid and shallow respiration. That this had no organic basis was readily shown, inasmuch as a little training served usually to cause breathing to become absolutely normal. The shortness of breath, dyspnea from which all complained most piteously, was not a true dyspnea, and it was not accentuated by reasonable exercise except, of course, in cases in which a real cardiac exhaustion or lesion had developed.

Adams and Sturgis [42] made a study of the vital capacity of the lungs and of the combining capacity of the blood in cases of effort syndrome. Their study, which was conducted on a group of 100 cases, tended to show that the vital capacity of the lungs of these men was but little below what has been accepted as normal, corroborating the well-established clinical observation that these patients do not suffer with a true dyspnea, but that their complaint of shortness of breath is founded on a neurosis and doubtless somewhat dependent on early muscle exhaustibility. Similarly, this was corroborated by the findings of these investigators that the combining capacity of the blood is found to be well within normal limits. This apparently shows that Lewis's theory of a decrease in the buffer salts in the blood as an explanation of shortness of breath is not well founded.

Levine and Wilson,[53] on the other hand, found that the average vital capacity of the lungs was slightly but definitely reduced in the severer cases of "D. A. H." They believed that the discomfort which deep breathing brings on in these persons was a factor. Exercise, they found, considerably reduced the vital capacity of the lungs, probably due, at least in part, to fatigue.

Drury [54] found that the percentage of carbon dioxide in the alveolar air, taken at rest, is within the lower limits of normality, or is decreased in these cases. The reaction of the alveolar carbon dioxide pressure to exercise is similar to and of the same order as that found in the healthy subject. The time during which the breath could be held is much less than in healthy subjects. The percentage of carbon dioxide in inspired air which produces intolerable hyperpnea is below normal, except in very mild cases.

A certain number of these men were held under the suspicion of being tuberculous. This diagnosis has usually been considered because of the general build of the man, from his asthenic attitude and improper carriage, and from his easy exhaustability rather than because of suspicious pulmonary signs. Quite naturally low stamina, particularly against the infections, is clearly a complication and not a part of the disease itself. These men appeared also to be particularly susceptible to pulmonary infections of all sorts to bronchitis, pneumonia, and to the effects of the war gases.

56706—28——37

NERVOUS AND MENTAL SYMPTOMS

Nervous and mental symptoms are very important in the syndrome. Few cases are free from this group of symptoms, which, to a considerable extent and in many instances, entirely dominated the case. Roughly, from a mental standpoint, one may group all the cases under two heads. The larger group is composed of men who are hypersensitive, neurotic, imaginative, often to the point of genius —all were unstable in a nervous way. These soldiers are quick in perception, overly intelligent in many ways, but too imaginative to permit them to become made over into stable line soldiers. Yet these very characteristics made them often very desirable as bandsman, clerks, stenographers, and the like. Several officers of brillant records were definitely of this classification, and there can be no question but that in some circumstances the very defects which are part of this disorder become attractions increasing efficiency under special demands and circumstances.

The other group was composed of excessively dull individuals. Most of the individuals of this group were of the heavy, obese type, slow and weak in physical effort, and puerile and illogical mentally. Many were large, ill-shapen, and strongly suggested hypothyroid types, or pituitary individuals. The last material was valueless for any military purpose; they became so quickly exhausted that they were useless for labor purposes; they were not sufficiently intelligent for line duty, even had they had the physical or moral stamina demanded of the good soldier; they were not sufficiently teachable even to learn any less complex duty, and at the same time they possessed all the nervous instability of the first-mentioned group. They would become hysterical on the slightest provocation and were subject to attacks of melancholia and depression which made them a nuisance in any position, a very positive detriment to the whole Military Establishment. Associated with these characteristics and present in both groups was an intense sense of apprehension, a fear complex which in men of a higher type was controlled and often conquered by a sense of duty, patriotism, and self-sacrifice, but which, in the lower classification, made these men of a particularly difficult type to adapt in the military organization. Of this obese, pituitary-hypothyroid type was composed a considerable list of "conscientious objectors," their objection being primarily based on a fear complex, but in a so low-grade mentality that one could not question their honesty. Of this type also were many of the so-called "religious" type of objectors.

Among the numerous nervous disturbances associated in the disorder are various tics, tremors, twitchings of the face and extremities, strongly suggestive at times of chorea, and sometimes a disseminated sclerosis is closely simulated. Sbrocchi [55] emphasized the importance of tremor of the eyelids when the eyes are closed, and directed attention to an attenuation of the conjunctival and pharyngeal reflexes. As a rule all the normal reflexes are increased, the knee, ankle, wrist, and arm jerks are especially exaggerated, and there is a hyper-excitability manifest in practically all reactions. The frequent association of hysteria in these individuals is very striking. Exaggeration is a mental trait of these persons, so much so that little trust could be imposed on them, notwithstanding the honesty of their desire.

Sleep, in sufferers from neurocirculatory asthenia, is commonly fitful and insufficient. Many patients are haunted by dreams which more or less visualize

the worries and stresses of the day. Yet soldiers are more than ordinarily dependent upon sleep and rest, and no doubt a considerable factor contributing to the break of these men under battle condition is loss of sufficient sleep.

Closely associated with the nervous manifestations of the disease is a condition of asthenia, or early exhaustibility, which was evident in every branch of activity, mental or physical. The researches of King,[56] using the white vasomotor reaction of Ryan, indicate the rapid and profound exhaustion in the subjects of this disease. The fatigue, in his opinion, may thus be measured, and is of actual physical nature and not purely of psychic origin. These studies tend to corroborate the clinical observations concerning the disease in the early studies of Da Costa. Few of these men would attempt anything in the nature of competition in physical sports; or if they did, they would quickly develop inaccuracy in physical or mental judgment, breathlessness, pain in the heart, and great muscle uncontrol. The gait, as a rule, was weak and shuffling, like that of a person convalescent from some grave disease. Even mental effort caused a degree of prostration altogether out of proportion, while the intense emotional episodes, such as anger, were followed by a very profound reaction. In subjects who have broken under stress, and in a limited number of spontaneous cases, exercise gradually introduced and intelligently supervised greatly increased endurance and strength. This effect was particularly manifest in some of the training battalions and was very evident to us in the base hospital at Camp Upton, where, for a short time, we were able to carry out tests of this character.

Mabon [57] made a study of early exhaustibility in neurocirculatory asthenia in a group of 50 well-established cases. The individuals were subjected to as severe work tests as they could be induced to undergo. Pulse and blood pressure studies were made. It was definitely shown that the amount of work which they could do without exhaustion was much below the normal. The pulse and blood pressure studies did not, however, indicate any abnormal myocardiac exhaustion. This study substantiates our clinical contention that the early exhaustibility of these cases is not dependent on cardiac defects but on general muscular and nervous deficiencies.

Laubry and Esmein [58] often observed a tendency toward hyperthermia in cardiac irritability. The tendency is not marked, and only slight thermic shifts take place from time to time. It occurs mostly in persons who have indulged in some kind of physical or mental activity just before the temperature is taken. An hour in bed causes it to disappear. They were unable to connect this phenomenon with any present or subsequent infection, or with tuberculosis. Aubertin [59] reported similar observations.

An important picture, not of great military occurrence, but which appears quite frequently in neurocirculatory asthenia in civil practice, is seen in attacks of syncope in which consciousness is completely lost.[24 60] These attacks simulate epilepsy quite closely and are very frequently mistaken for it. Because of this confusion with epilepsy, very few individuals who suffer from this particular symptom are admitted to the military service. Either they are rejected because of the history of the attacks or, if attacks occur in recruit barracks, the man is promply rejected, usually under the diagnosis of epilepsy.

DIAGNOSIS

Diagnosis depends chiefly on tachycardia, associated with palpitation, heart consciousness, precordial distress, and the very unstable neurovascular reflexes. Sweating, cyanosed or ischemic extremities, all of which develop under emotional rather than physical stimuli, are further diagnostic points of very similar origin. The presence of these conditions without adequate physical explanation are most suggestive. Emotional and nervous instability, fear complexes, hysterical manifestations, tremors, and more or less vagotonia are the chief nervous phenomena of diagnostic value. Some diagnostic assistance may be afforded by the hereditary factors and some by the sexual inadequacies which are likely to be present. Some stress may be justly laid on the physical types mentioned, on early exhaustion, and especially important diagnostically is an otherwise unexplained and always dominant asthenia.

The picture of hyperthyroidism may or may not be present. It is usually demonstrable in the spontaneously developed instances, but often entirely absent in those which have developed under stress. It will be noted, thus, that the most striking diagnostic signs are apparent on inspection and from the history of the patient, developing, as it is almost certain to do, a story of various inadequacies.

Careful physical examination, showing, as it will in most cases, largely negative findings, is very important, particularly since its negative character excludes the other conditions, tuberculosis, pure hyperthyroidism, and diseases of an exhaustive character, such as gastric or duodenal ulcer or neoplasm, which are most likely to be confused with the syndrome. In other words, diagnosis is by exclusion. Fleuroscopy has also been found to be a very helpful diagnostic method, not only because of its value in excluding disease of an organic nature, but also because the hypoplastic and often drop type of heart is most readily demonstrated by this method.

Snap diagnosis is a very dangerous procedure in these cases, tempting as the method is in military practice. When the list of serious organic disease conditions which may be readily confused with this syndrome is considered, the necessity of careful study is fully apparent. One must recall also the frequency with which serious secondary conditions, especially the infections, develop in the course of the disturbance. From a military standpoint, however, diagnosis, in so far as value to the service is concerned, is far from difficult. Except for highly specialized types of service, and only in exceptional instances otherwise, these subjects are undesirable for military duty, and the best procedure is their early elimination.

PROGNOSIS

Prognosis, from the military standpoint, does not seem to be a matter of very great difficulty or importance. With few exceptions men affected primarily by this syndrome are not suitable for line military duty. Depending on the type of the disease and on the degree, selected individuals, however, may be often most advantageously employed in the Military Establishment. Bandsmen of the better type are comprised in considerable part of types either with the syndrome fully developed or likely under the stress of war conditions

to develop it. If they are not of such a degree as would be likely to fail and to become a charge on the Military Establishment, they may continue in this capacity with full degree of efficiency. They may also be employed in clerical positions, as stenographers, in the rehabilitation activities, and in very many office positions for which their previous occupations may have particularly fitted them. They should always be excluded, however, with the greatest possible care from positions in which cool judgment, endurance, and powers of analysis are requisites.

In creative and imaginative channels their efforts are frequently of extraordinary value. They are not, however, a dependable military material. To a certain degree the same general facts must pertain in civil life, but under ordinary civil conditions curative progress is largely possible, particularly if the man may be kept under proper mental and occupational environment. The prognosis as a whole is far better in the acquired cases than in those in which the condition has developed spontaneously or from certain hereditary traits.

Very much in prognosis depends on environment and on the cooperation of the patient. In instances which have developed as a result of war stress obviously rest is the chief essential, and the same is true when for any reason the heart muscle has become seriously compromised. Obviously, then, prognosis may depend essentially on the possibility of securing rest. In the congenital cases, or those which have broken under the stress of ordinary life, more depends on a suitable environment and on adjusted training. On the possibilities of these hangs prognosis. Briefly, the military value of either class is very limited and circumscribed. Their increased vulnerability to all the infections and to shock of all kinds, and their natural limited duration of efficiency and life, must be always considered.

TREATMENT

From a military standpoint the first step in the treatment of this condition is the elimination from line duty of all except the very exceptional soldier, particularly officers whose experience or service has justified the hope that they may again be able to stand the full rigor of military duty. Even these men should be selected mostly for training purposes, rather than for actual line service. From the remaining group should then be selected men who, because of their special training or education, are peculiarly qualified for some particular service with troops and who are not so severly affected as likely to become a charge on the service. Among such men may be mentioned musicians, draftsmen, clerks, suitable for quartermaster or other clerical positions, men trained in telegraphy, telephony, or other work of value to the special corps, stenographers, typists, translators, and cooks. No men not specially qualified should be selected for duty with troops. Next are to be selected men whose training especially fits them for duty with the services of supply, such as clerks, stenographers, architects, carpenters, plumbers, and similar craftsmen, printers, classification and quartermaster clerks, storekeepers, bookkeepers, chemists, artists, and any other whose special services might be found of particular value.

Among neither of these groups should advanced cases of the syndrome be permitted, for the stress in any of these positions might at any time become so great as to cause a break, and so possibly incommode necessary routine. All other recruits showing this complex should be promptly discharged just so soon as a tentatively correct diagnosis has been arrived at.

Where line soldiers have broken down with the condition under service stress, after adequate treatment in base institutions they should be reclassified and assigned to base or other similar duties. The experience in practically all armies has shown the inadvisability of returning these men to combatant organizations, and for the greater part discharge and return to civilian activities is the better in so far as the Army is concerned.

When for political or other reasons, initial cases of the syndrome are required to be held in the Army, recognizing that this is from a standpoint of military efficiency an expensive, unremunerative, and entirely inadvisable procedure, they should be organized into companies or battalions under the command of junior medical officers who are well familiar with both professional and general military life and procedures. A temperate but firm military discipline should be maintained in these organizations, and they should be graded in so far as possible so that severe instances are not grouped with the milder types of the disturbance. A promoting system from the more severely affected companies to the less disabled ones should exist, and the constant hope and expectation of eventual full military duty should be held out to these men, although of course this is practically not a probability.

These men should be drilled in the school of the soldier, the length and type of the drill being adjusted to the possibilities of the company, and an attempt should be made to constantly, though very cautiously, increase the work. Meantime each man should be selected and classified for some special duty which he might subsequently take over after a preparatory course of training. It was found very important in the treatment of these groups at Camp Upton to constantly hold before the men that they were to be considered as soldiers under training. They must live under military conditions, as closely simulating those of the regular battalion as possible, and minor military duties and ceremonies may be undertaken by the more advanced classes. The definite improvement in self-respect and general morale under such conditions is very marked. In the treatment of this class of cases an appeal to the spiritual and mental attitude of the patient is necessary. Very close individual attention may be exercised by the medical officers in command of these training battalions. The food must be selected with greater care than is necessary in regular line troops, and greater care is necessary in its preparation. The bowels must be kept well opened, comfortable sleeping quarters must be provided, and regularity in every respect must be especially insisted upon. All foci of infection must be eliminated and all secondary disease processes must receive treatment. Tobacco and alcoholics are permissible in temperance only.

Experience has shown that a real military régime is far the best in any large concentration camp, but particular discretion must be exercised in all disciplinary measures, and chronic offenders should be hospitalized as being in a way irresponsible. All cases of this kind should be sent to the psychiatrist.

He will find very much material of this unstable character in these groups. Initial cases which require hospitalization, either because of temperamental vagaries or because of physical inadequacies, should be discharged from the service as soon as possible.

Medicinal treatment in initial cases is a failure except as drugs may be employed for the mitigation of transitory conditions or for symptomatic reasons. As a rule, digitalis, even given in massive doses, affects the action of the heart little or unfavorably. The same is true of other cardiac stimulants, while strychnia, caffeine, and similar drugs almost invariably make the condition worse rather than better. Sedatives act much more satisfactorily, and since protracted employment is to be expected if any benefit is conferred it is necessary for this purpose not to employ, except for very transitory use, drugs of the opium group. Bromides act very well in many cases, but sooner or later lose their beneficial effect if long employed. Luminal has been used with good effect. No drugs, in our experience, have conferred other than transitory benefit. The use of various endocrine preparations in early cases admits of a complete theoretical justification. In cases associated with obesity small doses of thyroid cautiously employed has acted well, especially if associated with pituitary preparations also. Stoney [51] claimed good results from X-ray treatment of the thyroid. Various preparations of the sexual glands have also been recommended, and their use is at least apparently without any detrimental effect. If associated with close supervision of the case, particularly with control of physical and mental activities, excellent effects are to be expected in early cases from the treatment of this syndrome along endocrine lines. Hospitalization of initial cases is to be avoided, except when absolutely necessary, but in some instances it has given excellent results. Great care in hospitalization cases must be exerted to prevent the development, intensification, or fixation of varous phobias. It must be particularly insisted upon throughout that the disease is not one of the heart.

The treatment of cases which have developed under the stress of service is distinctly a military problem, and such cases should not be discharged, at least until they have received the maximum benefit possible under treatment. The degree to which this may be attained depends not only on the severity of the breakdown and on the status of the patient, but also very largely on the character of treatment which he receives and especially on the intelligence and vigor of the early management of these cases. The first essential is rest. This should be made as complete as possible, and if practicable the patient should be evacuated back at least out of the army zone just as soon as it can be safely accomplished. Sedatives should be employed, and such as will control the nervous manifestations present should be promptly used to their therapeutic effect. Later the more powerful ones should be replaced by less powerful drugs, but the effect desired should be attained. Only where doubt exists as to the integrity of the heart muscle should digitalis be given. The ice bag may be placed over the precordium, where it relieves either the pain or the tachycardia. The patient should in all possible cases be put to bed in as quiet surroundings as possible. He should be relieved in so far as possible from military discipline for the time being, and where it is possible to evacuate him to home hospitals

this should be done, but he should be held under military medical supervision and treatment. After a rather protracted period of rest treatment he should be slowly relieved from hospital restraint, though not from medical supervision, and as soon as the cardiac and nervous symptoms permit he should be advanced to graduated exercises and finally to the training battalions, through which a gradual restoration to normal military life may be attained. He should not, however, except under very exceptional circumstances and through military necessity, or because of some especially valuable qualification, be returned to line duty, but he should be reclassified and assigned to such service as he may be particularly fitted for, preferably without the active army zone.

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CHAPTER XXII

DECISIONS AS TO WHETHER OR NOT DISABILITIES WERE IN LINE OF DUTY

A duty devolving on the Medical Department for many years has been the expression of a professional opinion by the medical officer concerned whether a disability arising in the course of a soldier's service and necessitating his discharge was in consequence of such service, or, in military parlance, was "in line of duty." This was deemed necessary from the military standpoint in view of the fact that from our earliest history as a nation our Government has considered itself obligated to compensate soldiers suffering physical or mental harm while performing military duty on its behalf.

LAWS, REGULATIONS, AND DECISIONS GOVERNING THE LINE OF DUTY DECISION

The first enactment in this country with reference to military pensions was a resolution passed by Congress on August 26, 1776, in which it was provided that all soldiers in the Revolutionary War who had lost a limb, or otherwise had become disabled, should be granted a pension. Since that time various statutes of the United States have provided for the payment of pensions to any person disabled as a result of military service. As the disability must have been incurred "in line of duty," the War Department has always required an expression of opinion on this point from the medical officer who submits any report in the case of a sick or wounded soldier. Likewise this is so specified on the certificate of disability for discharge.

Prior to the act of Congress approved October 6, 1917 (which amended the act of September 2, 1914, authorizing the establishment of the Bureau of War Risk Insurance), the monetary relief allotted to a disabled soldier after discharge from the Army, or to the relative of a deceased soldier, was known as a "pension." Since the date of the above-mentioned enactment the term "compensation" has been used. Prior to this act the consideration of all questions relative to the adjudication and payment of pensions had for many years been under the jurisdiction of the Bureau of Pensions. While this bureau did not consider final the opinion of the War Department as to whether a death or disability was incurred in line of duty or not in line of duty, nevertheless it is safe to say that the adjustments made by the Pension Bureau were in the vast majority of cases based upon the records of the War Department. For this reason an expression of opinion regarding the line of duty status in each instance was regarded by every medical officer of the Army as of great consequence, since he must assure himself that no injustice be done to any individual, while at the same time safeguarding the interests of the Government. If there were any uncertainty in a given case, the soldier received the benefit of the doubt; rarely could exception be taken to the decision reached. Certain pensions for alleged disability were granted, however, by special acts. For some such bills neither the opinion of the War Department nor that of the Pension

Bureau exercised any influence. Yet, under the old pension system, the adjudication of claims generally was largely based on professional opinion—in the first instance, that of medical officers.

Since the passage of the amendment of October 6, 1917, to the war risk insurance act, all soldiers discharged subsequent to the above date of approval, and certain soldiers discharged since April 6 of that year, were entitled to compensation but not to pension. The disbursement of compensation is under control of the Bureau of War Risk Insurance, a branch of the Treasury Department; the Pension Bureau is not concerned.[a]

The directions which for many years before the World War guided medical officers in determining whether or not a disease or injury was incurred in line of duty were published in the Manual for the Medical Department. In the 1916 edition of this Manual, the edition in effect during the World War, paragraph 448–a reads as follows:

All diseases or injuries from which an officer or enlisted man suffers while in the military service of the United States may be assumed to have occurred in the line of duty; unless the surgeon knows: First, that the disease or injury existed before entering the service; second, that it was contracted while absent from duty without permission; or, third, that it occurred in consequence of willful neglect or immoral conduct of the man himself. When the patient is admitted for an operation or procedure which is designed to improve his physical fitness or efficiency for the military service, such operation or procedure will be recorded as in line of duty, without reference to the fact whether the condition to be remedied originated in the line of duty or not, provided that the primary cause is not the result of the patient's own misconduct.

The provisions quoted were in effect until May 11, 1918, when General Orders, No. 47, War Department, 1918, were issued; Section II thereof reads as follows:

Hereafter any soldier who shall have been accepted on his first physical examination after arrival at a military station as fit for service shall be considered to have contracted any subsequent determined physical disability in the line of duty unless such disability can be shown to be the result of his own carelessness, misconduct, or vicious habits, or unless the history of the case shows unmistakably that the disability existed prior to entrance into the service. The same ruling shall apply in the cases of officers who have been passed as fit for service on physical examination upon entrance into the service.

On June 15, 1918, the Manual for the Medical Department was amended by Changes No. 8 to conform with the provisions of General Orders, No. 47, paragraph 448–a, then reading as follows:

An officer, Army field clerk, or field clerk, Quartermaster Corps, who has been passed as fit for service on physical examination upon entrance into the service or a soldier or member of the Nurse Corps who has been accepted on his or her first physical examination after arrival at a military station as fit for service shall be considered to have contracted in the line of duty any subsequently determined physical disability, unless such disability can be shown to be the result of the patient's own carelessness, misconduct, or vicious habits, or to have been contracted while absent from duty without permission, or unless the history of the case shows unmistakably that the disability existed prior to entrance into the service. When the admission is for an operation or procedure which is designed to improve the patient's physical fitness or efficiency for the military service, such operation or procedure will be recorded as in the line of duty, without reference to the fact whether the condition to be remedied originated in the line of duty or not, provided that the primary cause is not the result of the patient's own misconduct.

[a] The functions of the Bureau of War Risk Insurance were invested in the United States, Veterans' Bureau, August 9, 1921, — *Ed.*

In arriving at a conclusion as to whether a disease or injury was incurred in line of duty, there was seldom any cause for hesitancy in the earlier days in rendering the decision except in cases where it was a question whether the disability had existed before entrance into the military service. Until May, 1918, the existing regulations placed the responsibility for this decision directly on the medical officer concerned, who must satisfy himself whether or not the physical defect existed prior to such service. In determining this question he necessarily relied on his judgment in each case, basing his opinion not only upon the history obtainable but also upon the extent and character of any lesions which existed, interpreted in the light of his professional knowledge. Especial attention was given to the degree of involvement of any part of the body which was affected as related to the length of service of the individual soldier concerned. If the medical officer was thoroughly satisfied (after having obtained any necessary consultation which was available) that the disability must have existed prior to the onset of the patient's military career, the condition was regarded as not incurred in line of duty and such a notation was made on the official records of the individual under examination.

The line of reasoning was as follows: At the time applicants for enlistment are examined for entrance into the military service, it is sometimes impossible for the medical examiner to detect certain types of defects. Individuals having enuresis, epilepsy, incipient dementia præcox, paresis, and psychoneurosis, or defective mentality, will sometimes inevitably be accepted by the most competent and conscientious examiner. Certain cases of inactive tuberculosis also will be passed. Numerous other puzzling conditions might be mentioned, and the number of cases escaping detection at once will always be greater under a press of work and with inexperienced examiners. Soldiers with such undetected serious defects will necessarily soon come up for discharge because of physical disability; and if a medical officer can then determine the true facts, strict justice can be done and at the same time the Government will be saved a very large sum which otherwise would be paid out in pensions for disabling conditions in no way dependent upon military service.

With the modifications governing the determination of "line of duty," which were promulgated by General Orders, No. 47, as quoted above, it was realized that a strict interpretation of the word "history" would greatly restrict the investigation which the medical officer was required to make in determining the line of duty status. The question at once arose whether the term "history" meant solely a statement obtained from the patient, or from others, relative to his physical condition prior to enlistment, or, whether the results of physical examinations, laboratory findings, X-ray plates, etc., could be included in this term. The matter was submitted to the Judge Advocate General for an opinion (see case of W. W., p. 593), but this particular phase of the question was ignored. It was the opinion of the Surgeon General, however, that the word "history" in medical nomenclature refers exclusively to the statement of the patient, or to statements of others having direct knowledge as to the patient's previous condition, and that only facts so elicited should be considered in this connection. Therefore, it was also his opinion that a medical officer would be justified in classing such a case as not in line of duty solely when a definite and unmis-

takable statement that the disability actually existed prior to entering the service was obtainable. It was regarded as fairly certain that in most cases when there was such a history a thorough questioning of the soldier would bring out the facts.

Having considered the provisions of the Manual for the Medical Department and the general orders of the War Department, under which medical officers were required to act in the determination of line of duty status, we now come to consideration of the war risk insurance act.

It will be observed that all of the preceding regulations provided that, from the military point of view, a disability clearly established by the history to have existed prior to enlistment was not in line of duty. From the compensation standpoint a new factor was introduced by the war risk insurance act. Section 300 of this act, as amended, is as follows:

> That for death or disability resulting from personal injury suffered or disease contracted in the line of duty, by any commissioned officer or enlisted man or by any member of the Army Nurse Corps (female) or of the Navy Nurse Corps (female) when employed in the active service under the War Department or Navy Department, the United States shall pay compensation as hereinafter provided; but no compensation shall be paid if the injury or disease has been caused by his own willful misconduct: *Provided*, that for the purposes of this section said officer, enlisted man, or other member shall be held and taken to have been in sound condition when examined, accepted and enrolled for service: *Provided further*, that this section, as amended, shall be deemed to become effective as of October sixth, nineteen hundred and seventeen.

An amendment to this section, approved December 24, 1919, provided that the benefits of the act should become effective April 6, 1917, in place of October 6.

The feature of section 300 which demands special consideration at this point is the provision that every officer, enlisted man, or nurse "shall be held and taken to have been in sound condition when examined, accepted, and enrolled for service." There could be but one interpretation of this act. Every such person who had been accepted for service was at that time legally in "sound condition"; consequently, any disability discovered thereafter while such person remained in the service (unless incurred through the individual's willful misconduct or when absent without leave) was, for purposes of compensation, in line of duty, even though the history clearly showed that it existed before entering into the military contract. This was a revolutionary change involving greatly increased obligations on the part of the Government and in consequence increasing its expenditures for compensation by millions of dollars annually.

General Orders, No. 47, War Department, 1918, and paragraph 448–a, Manual for the Medical Department, were in nowise modified to meet the provisions of the war risk insurance act in this respect. The existence of the law, as applying to such cases, was unknown to many officers, and they continued to follow the requirements of the Medical Department Manual and the general orders. Some officers who were cognizant of the law believed that it had no bearing on the War Department and that in preparing reports regarding sickness and discharge they must be guided by the instructions issued in the official War Department publications. It was therefore to be expected, as

was the case, that in a short time numerous complaints and requests for changes in individual reports regarding line of duty status would begin to arise. The Judge Advocate General of the Army consistently held that, for purposes of compensation, any disability which existed prior to entry into the service must be regarded by the military authorities as incurred in line of duty, since the law declared the soldier sound at the time of acceptance. It was furthermore held by the Judge Advocate General that no attempt should be made by medical officers concerned to ascertain the history of the soldier prior to his entrance into the Army. Several of these opinions of the Judge Advocate General, which were approved by the Secretary of War, are here quoted:

[Sixth indorsement [1]]

WAR DEPARTMENT,
JUDGE ADVOCATE GENERAL'S OFFICE,
April 1, 1919.

TO THE ADJUTANT GENERAL:

1. Reference A. G. 201 (K., E. M.) Enl., March 28, 1919. The opinion of this office is requested whether or not the disability resulting in the discharge of, K. E. M., private, Battalion 15, Camp Greenleaf, Medical Department, United States Army should be regarded as in line of duty and not the result of his own misconduct. Lieut. Clarence R. Miller, assistant camp neuropsychiatrist, made an examination of Private K. on August 20, 1918, and recommended his discharge for disability, dementia præcox, paranoid type, and stated that the disability occurred prior to the enlistment. Private K. was discharged on November 16, 1918, his discharge under the heading of "Remarks," containing the conclusions of Lieutenant Miller.

2. It appears from the papers in reference that Private K. had frequent attacks of the blues, noticed people acting peculiarly toward him since he was a boy; never had been much of a mixer; never associated with women; complained that the men in his company had it in for him, and that they made unfounded accusations against him with officers; that he thought they were going to have him court-martialed. He became despondent and homesick. He admitted having contemplated suicide several times, but attempted it only once. He had delusions of persecution, showed some thought blocking, and had some insight into his condition.

3. It is the opinion of this office that, under paragraph 2 of General Orders, No. 47, May 11, 1918, the disease should be regarded as having been incurred in line of duty. (Ops. J. A. G. 220.4, July 31, 1918.) With respect to compensation under Article III, section 300, of the war risk insurance act (40 Stat. 398, 405), as amended (Pub., No. 175, 65th Cong. p. 3), a soldier must be regarded as in sound condition when accepted for service. (Ops. J. A. G. 220.4, Oct. 22, 1918.)

(Signed) E. A. KREGER,
Acting Judge Advocate General.

[Eleventh indorsement [2]]

WAR DEPARTMENT,
JUDGE ADVOCATE GENERAL'S OFFICE,
March 6, 1919.

TO THE ADJUTANT GENERAL:

1. Reference A. G. 201 (H., B.) enl., March 4, 1919. The opinion of this office is requested upon the question whether or not the death of Pvt. B. H., Company G, 3d Infantry, should be regarded as having been incurred in line of duty and not as the result of his own willful misconduct. The board of officers appointed to investigate the death found that it was the result of suicide, that at the time of the suicide the accused was not responsible for his acts, and that the death was in line of duty and not the result of the decedent's own willful misconduct. The proceedings were sent back for consideration of the question whether

the mental condition of the accused was incident to or a result of his military service or whether it existed prior to enlistment. The board then found that the mental condition existed prior to enlistment, and amended the third paragraph of its original findings so as to find that the death was not in line of duty.

2. The death of Pvt. B. H. should be regarded as having been incurred in line of duty and not as the result of his own misconduct. The evidence is ample to support the findings of the board to the effect that the death was the result of suicide and that at the time of the suicide the decedent was not mentally responsible for his act. The fact that the mental condition may have existed prior to enlistment is entirely immaterial. Section 300 of the war risk insurance act, as amended by the act of June 25, 1918 (40 Stat. 611), specifically provides that an enlisted man shall be held and taken to have been in sound condition when examined, accepted, and enrollod for service.

(Signed) E. H. Crowder,
Judge Advocate General.

WAR RISK INSURANCE; LINE OF DUTY; PRESUMPTION OF SOUND PHYSICAL CONDITION AT TIME OF ENLISTMENT

A soldier five months after enlistment was discharged on a surgeon's certificate of disability. The board of medical officers based its findings that the disease, dementia præcox, was incurred prior to enlistment and not in line of duty, upon the statement of the soldier that about four years previously he had had serious domestic trouble and at that time had been in a sanitarium and was restless and worried. Held, that, under paragraph 2 of General Order No. 47, May 11, 1918, the disease should be regarded as having been incurred in line of duty. (Ops. J. A. G. 220.4, July 31, 1918.) With respect to compensation under Article III, section 300, of the war risk insurance act, as amended (40 Stat, 398, 405), a soldier must be regarded as in sound condition when accepted for service (Pub. No. 175, 65th Cong., P. 3). (Ops. J. A. G. 220.4, October 22, 1918.)

[Fourth indorsement [3]]

War Department,
Judge Advocate General's Office,
March 18, 1919.

To The Adjutant General:

1. Reference A. G. 201 (M., A. L.) enl., March 15, 1919. Opinion is requested upon the question whether the death of Pvt. A. L. M. should be regarded as having occurred in line of duty and not as the result of his own willful misconduct. It appears that M. was inducted into the service by local board No. 3, County of York, York, Pa., on August 31, 1918, and reported on that date to the training detachment, Spring Garden Institute; that at 6.45 p. m. of the same day he had an epileptic fit and was removed to Jefferson Hospital, Philadelphia, Pa., at which place he died on September 4, 1918, from epilepsy. He was never examined physically after reporting to the training detachment.

2. This office has consistently held that a man enters the active military service within the meaning of Article III of the war risk insurance act when he is inducted into the service, that he should be regarded as in sound condition at the time of such induction, and that any supervening disability occurring while he was in a duty status should ordinarily be regarded as having occurred in line of duty. The War Risk Insurance Bureau has, however, ruled that a soldier does not come within the protection of the war risk insurance act until after he has been finally examined and accepted by the Army surgeons at the mobilization point to which he is sent by the local draft board. Under section 13 of the war risk insurance act the decision of the Director of the Bureau is conclusive upon this point. Consequently, within the rulings of the Bureau of War Risk Insurance, the death of Private M. must be regarded as having occurred not in line of duty, although it can not be regarded as having occurred as the result of his own willful misconduct.

(Signed) E. A. Kreger,
Acting Judge Advocate General.

WAR RISK INSURANCE; EFFECT OF DISABILITY ARISING SUBSEQUENT TO ACCEPTANCE FOR GENERAL MILITARY SERVICE; LATENT DEFECTS

A soldier was inducted into the service and accepted by the board of Army surgeons at a camp as physically qualified for general military service. Subsequently he became disabled. If disability resulted from an aggravation of a disease which the soldier had prior to his acceptance for service and such aggravation was cause by his military service and not by his willful misconduct, he is entitled to compensation under section 300 of the war risk insurance act. (40 Stat. 398, 405.) If he is entitled to such compensation, he is also entitled to reasonable medical, surgical, and hospital services, as provided by subsection 3 of section 302 of the act. (40 Stat. 398, 406.) Inquiry as to whether a disability existed prior to enlistment should not be made in the case of a soldier who was found physically fit and accepted for general military service. (Ops. J. A. G. O. 04.6129, Dec. 11, 1918.)

There could of course be no question but that, for purposes of compensation, every soldier should be considered, under the existing law, as physically sound at the time of acceptance, and under that law, even if at a latter time it could be clearly shown that a disability did exist prior to such acceptance, the soldier would nevertheless be entitled to receive compensation. However, the Surgeon General held that the war risk insurance act was without effect as regards the Military Establishment and maintained that the requirements of the Manual for the Medical Department should continue to govern medical officers in determining the line of duty status for entry on the individual reports of sickness and injury. The Adjutant General apparently at one time concurred in this opinion as shown by the following correspondence:[4]

DECEMBER 20, 1918.

From: The Adjutant General, United States Army.
To: The Commanding General, Camp Jackson, S. C.

1. In view of G. O. No. 47, W. D., May 11, 1918, the accompanying report of the medical officer in the case of W. W., private, Company D, 1st Provisional Regiment, 156th Depot Brigade, who died on November 20, 1918, is returned for reconsideration by the medical officer with respect to line of duty. If the medical officer adheres to his conclusion that the death of Private W. was not in line of duty, a statement will be rendered showing the reasons on which was based his conclusion.

2. Attention is also invited to the fact that the report of death is incomplete inasmuch as it is not stated whether the death of this soldier was or was not the result of his own misconduct.

3. The final statement and service record show the soldier was enlisted on February 23, 1919.

[First indorsement]

HEADQUARTERS, CAMP JACKSON, *December 24, 1918.*

TO COMMANDING OFFICER,
Base Hospital:

For compliance.

[Second indorsement]

C. O., B. H., CAMP JACKSON, *December 31, 1918.*

TO COMMANDING GENERAL:

Returned.

1. Private W. was admitted to base hospital less than one month after his enlistment with active pulmonary tuberculosis, both upper lobes, and was under treatment in the base hospital from March, 1918, until his death, November 20, 1919. His death was not in line of duty for the following reasons:

Length of service, less than one month before diagnosis was made.
Was not acute tuberculosis.
Was not brought on by any illness contracted in the Army.
So far as known the cause of death was not the result of his own willful misconduct.
Correction of report of death made as per paragraph 2 of letter.

[Third indorsement]

HEADQUARTERS, CAMP JACKSON, S. C., *January 1, 1919.*

To THE ADJUTANT GENERAL:

1. Returned, inviting attention to second indorsement.

[Fourth indorsement]

ADJUTANT GENERAL'S OFFICE, *January 18, 1919.*

To the COMMANDING GENERAL,
Camp Jackson, S. C.

Returned.

1. The statement set forth in the second indorsement is insufficient. Further information is desired as to whether there is unmistakable evidence that the disease resulting in the soldier's death existed prior to enlistment.

[Fifth indorsement]

HEADQUARTERS, CAMP JACKSON, S. C., *January 22, 1919.*

To the COMMANDING OFFICER,
Base Hospital, Camp Jackson, S. C.

For compliance.

[Sixth indorsement]

COMMANDING OFFICER, BASE HOSIPTAL,
Camp Jackson, S. C., January 31, 1919.

To THE ADJUTANT GENERAL:

Returned.

1. There is no unmistakable evidence that the illness existed prior to enlistment other than that as set forth in the second indorsement.

[Seventh indorsement]

201 (C) W., W. (Pvt.)

HEADQUARTERS, CAMP JACKSON, S. C., *February 3, 1919.*

To THE ADJUTANT GENERAL OF THE ARMY,
Washington, D. C.

Attention invited to sixth indorsement.

[Eighth indorsement]

WAR DEPARTMENT,
ADJUTANT GENERAL'S OFFICE,
February 8, 1919.

To the SURGEON GENERAL OF THE ARMY.

1. Referred, with request for his opinion as to whether the death of the late Pvt. W. W., Company D, 1st Provisional Regiment, 156th Depot Brigade, should be regarded as having been incurred in line of duty and also not the result of his own misconduct.

2. The records show that this soldier was enlisted February 23, 1918.

By order of the Secretary of War.

[Ninth indorsement]

S. G. O. 201 W., M.

WAR DEPARTMENT,
SURGEON GENERAL'S OFFICE,
February 14, 1919.

To THE ADJUTANT GENERAL OF THE ARMY.

1. Returned.

2. Paragraph 448, Manual Medical Department, as amended by Changes, M. M. D. No. 8, provides:

An officer, army field clerk, or field clerk, Quartermaster Corps, who has been passed as fit for service on physical examination upon entrance into the service, or a soldier or member of the Nurse Corps who has been accepted on his or her first physical examination after

arrival at a military station as fit for service, shall be considered to have contracted in the line of duty any subsequently determined physical disability, unless such disability can be shown to be the result of the patient's own carelessness, misconduct, or vicious habits, or to have been contracted while absent from duty without permission, or unless the history of the case shows unmistakably that the disability existed prior to entrance into the service.

3. In the case in question the history as obtained by questioning the soldier evidently did not show that the disability existed prior to entrance into the military service. However, it is believed the physical examination revealed a pathological condition of the lungs of such a degree that the disability must have existed prior to entrance into the military service. It is requested that the opinion of the Judge Advocate General be obtained as to whether the results of physical or other examination are to be considered as a part of the history of the case as this term is used in the above paragraph, or whether the history consists only of the verbal or written statement of the patient or others.

For the Surgeon General:

[Tenth indorsement]

WAR DEPARTMENT,
ADJUTANT GENERAL'S OFFICE,
February 21, 1919.

To the JUDGE ADVOCATE GENERAL:

1. Attention is invited to the foregoing correspondence. The opinion of the Judge Advocate General of the Army, as indicated by the Surgeon General of the Army in the ninth indorsement, is requested.

[Eleventh indorsement]

WAR DEPARTMENT,
JUDGE ADVOCATE GENERAL'S OFFICE
February 24, 1919.

TO THE ADJUTANT GENERAL:

1. The question presented is whether the death of W. W., late private, Company D, 1st Provisional Regiment, 156th Depot Brigade, was in line of duty and not the result of his own willful misconduct. Was admitted to the base hospital, Camp Jackson, S. C., one month after his enlistment, suffering with active pulmonary tuberculosis, and was under treatment in said hospital from March, 1918, until his death, November 20, 1918. The commanding officer of the base hospital reports that "so far as known, his death was not the result of his own misconduct," but is of the opinion that it was not in line of duty for the following reasons: "(1) Length of service, less than one month before diagnosis was made; (2) was not acute tuberculosis; (3) was not brought on by any illness contracted in the Army."

2. Under the foregoing statement of facts the only question to be determined is whether the death occurred in the line of duty. The commanding officer of the base hospital gives it as his opinion that it was not in the line of duty, apparently because the disease must have existed at the time of enlistment. Section 300 of the war risk insurance act, as amended by section 10 of the act of June 25, 1918 (Pub. 175, 65th Cong.), provides that an officer, enlisted man, or other member of the military service "shall be held and taken to have been in sound condition when examined, accepted, and enrolled for service." This statute creates a conclusive presumption, and W. must be held to have died in line of duty.

[Twelfth indorsement]

WAR DEPARTMENT,
ADJUTANT GENERAL'S OFFICE,
March 10, 1919.

To the SURGEON GENERAL OF THE ARMY:

1. Attention is invited to the opinion of the Judge Advocate General of the Army as set forth in the eleventh indorsement, which has been approved.

2. The early return of these papers is requested.

By order of the Secretary of War.

[Thirteenth indorsement]

WAR DEPARTMENT,
SURGEON GENERAL'S OFFICE,
March 22, 1919.

TO THE ADJUTANT GENERAL OF THE ARMY.

1. Noted.

2. Paragraph 448, M. M. D., as amended by Changes No. 8, provides in part that every physical disability from which a soldier suffers in the military service shall be considered to have been contracted in the line of duty "unless * * * or unless the history of the case shows unmistakably that the disability existed prior to entrance into the service."

3. This office does not believe that the pulmonary tuberculosis in this case could have reached the stage of development indicated in the second indorsement hereon within the period of less than one month following his enlistment. Accordingly this office must conclude, as a matter of professional or medical fact, that the pulmonary tuberculosis was contracted prior to the time the man entered the military service.

4. Conformably to the provisions of paragraph 448 of the Manual as hereinabove quoted, the Medical Department was therefore obliged to record this disability as not incurred in the line of duty. This office understands from the decision indicated in the eleventh and twelfth indorsements hereon that that record must now be changed to line of duty on the ground that the act of June 25, 1918, creates a conclusive presumption that every soldier who is accepted for military service is in sound condition when so enrolled.

5. The provisions of paragraph 448, hereinabove quoted, are, it will be observed, in conflict with that presumption, and unless they are altered medical officers hereafter, as heretofore, will be obliged to follow them. Instructions are requested whether any modification of paragraph 448 of the Manual is in contemplation to avoid the conflict which this correspondence brings out.

6. It is submitted for consideration in this regard that the rule laid down in the Manual urges the extreme limit of liberality which is compatible with the actual facts of disease, and that unless some modification thereof is made necessary by obligatory law it would be inexpedient to change that rule. This office has not understood that the proviso added to section 300 of the war risk insurance act by amendment of June 25, 1918, was intended to have or purports to have any obligatory force upon military administration. Section 300 in question relates exclusively to the payment of compensation for disabilities incurred in the military and naval services, such payment being a part of the business of the War Risk Bureau, and the proviso, dated June 25, 1918, establishes the presumption herein referred to "for the purposes of this section" only. This office would regard it as unfortunate if the proviso or law made for those purposes only should be extended by construction so as to apply to the administration of the Army with which it has ostensibly no conern, and require medical officers in many cases to express opinions which are repugnant to truth.

7. If, nevertheless, that law is to be applied to military administration, a number of collateral questions are bound to arise. Thousands of men were accepted and enrolled for limited service who upon acceptance were found to have physical defects or disqualifications for full service, among them men with one arm or one leg. Literally the law would declare them sound. It is difficult to believe, however, that the act of June 25, 1918, intends that a physical defect of this character existing before and noted at the time of enlistment shall be deemed, in derogation of the facts, to have been incurred in the line of duty in the military service.

[Fourteenth indorsement]

WAR DEPARTMENT,
ADJUTANT GENERAL'S OFFICE,
April 2, 1919.

TO CHIEF OF STAFF:

Requesting instructions.

A. G. 201 (W., W.) enl.

[Fifteenth indorsement]

WAR DEPARTMENT,
ADJUTANT GENERAL'S OFFICE,
May 6, 1919.

To the SURGEON GENERAL OF THE ARMY:

1. Returned. There is no necessity for amending the Manual of the Medical Department in accordance with section 300 of the war risk insurance act as amended by section 10, Public 175, Sixty-fifth Congress, provided that the Medical Manual is adhered to in its requirement that full reasons be given by the proper medical officers whenever a decision is reached that a particular disability did not originate in line of duty.

2. It is requested that these papers be returned to this office.

[Sixteenth indorsement]

S. G. O. 201 (W. M.).

WAR DEPARTMENT,
SURGEON GENERAL'S OFFICE,
May 9, 1919.

TO THE ADJUTANT GENERAL OF THE ARMY:

Returned.

1. Noted.

For the Surgeon General.

In view of this decision, when the facts in any case so warranted, the Surgeon General recommended that the disability be regarded as not incurred in line of duty, if such decision was in accordance with the requirements of the Manual for the Medical Department. These cases would then be referred to the Judge Advocate General, who in every instance held that under the provisions of section 300, war risk insurance act, as amended, the disability should be regarded as incurred in line of duty. This opinion was in every case approved by the Secretary of War. As this was in conflict with the instructions received in the fifteenth indorsement, as above quoted, the question was again presented in the following correspondence:[5]

SEPTEMBER 20, 1919.

From: The Adjutant General of the Army, Washington, D. C.
To: The Surgeon General of the Army, Washington, D. C.
Subject: Disability for discharge.

1. In the case of A. R., private, Company K, 22d Infantry, who was discharged on certificate of disability for discharge, August 27, 1919, attention is invited to the inclosed certificate in which the Board of medical officers state that the disqualifying disability did exist prior to enlistment and did originate in line of duty. It is thought that the opinion of the Judge Advocate General referred to is not applicable in this case.

2. An expression of opinion is desired as to whether or not the disability which disqualified Pvt. R. should be regarded as having existed prior to enlistment and whether or not such disability originated in line of duty.

[First indorsement]

SURGEON GENERAL'S OFFICE,
WAR DEPARTMENT,
September 24, 1919.

TO THE ADJUTANT GENERAL OF THE ARMY:

Returned.

1. In the opinion of this office, the disability in the case of Pvt. A. R. unquestionably existed prior to entry into the military service. It is, therefore, recommended that this disability be regarded as not incurred in line of duty.

[Second indorsement]

ADJUTANT GENERAL'S OFFICE,
WAR DEPARTMENT,
October 1, 1919.

To the JUDGE ADVOCATE GENERAL OF THE ARMY:

1. A statement is desired embodying an expression of opinion as to whether or not the disability which disqualified Pvt. R. for military service should be regarded as having existed prior to enlistment and whether or not such disability originated in line of duty.

[Third indorsement]

WAR DEPARTMENT,
JUDGE ADVOCATE GENERAL'S OFFICE,
October 2, 1919.

To THE ADJUTANT GENERAL:

1. Reference A. G. (NA) 201 (R. A.) enl., October 1, 1919, the opinion of this office is requested on the question whether or not the disability which disqualified Pvt., A. R., Company K., 22d Infantry for military service should be regarded as having existed prior to enlistment and whether or not such disability originated in line of duty.

2. The statement of the company commander in R.'s certificate of disability for discharge, Form No. 17, A. G. O., is that he was enlisted at Fort Jay, N. Y., "April 21, 9" and "became unfit for duty from present disease or injury July 19." It further appears from this certificate that this mental deficiency existed prior to enlistment; and that because of it R. was discharged at Fort Jay, N. Y., August 27, 1919.

3. Section 300 of the war risk insurance act, as amended (40 Stat. 609, 611), is as follows:

That for death or disability resulting from personal injury or disease contracted in the line of duty, by any commissioned officer or enlisted man or by any member of the Army Nurse Corps (female) or of the Navy Nurse Corps (female) when employed in the active service under the War Department or Navy Department, the United States shall pay compensation as hereinafter provided. But no compensation shall be paid if the injury or disease has been caused by his own willful misconduct: *Provided*, That for the purpose of this section said officer, enlisted man, or other member shall be held and taken to have been in sound condition when examined, accepted, and enrolled for service: *Provided further*, That this section as amended, shall be deemed to become effective as of October sixth, nineteen hundred and seventeen.

4. It is assumed from the foregoing recitals of the certificate of disability that the date of enlistment of R. was April 21, 1919. This being the case, while the disability in question did in fact exist prior to enlistment, for the purpose of compensation under the above act R. must be held and taken to have been in sound condition when enlisted. The disability can not, of course, be traced to any misconduct subsequent to enlistment; and it, therefore, follows that for the purpose of compensation under the act aforesaid, the disability of Pvt. R. should be regarded as having been incurred in the line of duty and not as the result of his own willful misconduct.

[Fourth indorsement]

WAR DEPARTMENT,
ADJUTANT GENERAL'S OFFICE,
October 21, 1919.

To the SURGEON GENERAL OF THE ARMY:

To note and return. The recommendation set forth in the third indorsement has been approved.

By order of the Secretary of War.

[Fifth indorsement]

WAR DEPARTMENT,
SURGEON GENERAL'S OFFICE,
October, 28 1919.

To THE ADJUTANT GENERAL OF THE ARMY:

1. Returned, noted.

2. No doubt is entertained that the decision made in the third indorsement hereon is inevitable so far as concerns the administration of the war risk insurance act of October 6, 1917, by the Treasury Department, and that the authorities of that department are concluded

in respect to line of duty by the terms of section 300 of the act cited, as amended June 25, 1918. It is submitted, however, that that law does not relate to, or govern the action of, the authorities of the Army in determining questions of line of duty, and that such authorities are free to record the truth in reference thereto, notwithstanding the conclusion of law set up by the provisions of the act of June 25, 1918.

3. The rule for determining line of duty in the Army is prescribed by the Secretary of War in paragraph 448, Manual for the Medical Department. Question whether that regulation required alteration in order to incorporate therein the conclusion of law set up by the act of June 25, 1918, was presented by thirteenth indorsement, this office, March 22 last, to The Adjutant General, in the case of W. W., and decided by the Secretary in the negative, per fifteenth indorsement, Adjutant General's Office, May 6, 1919, to the Surgeon General.

4. In conformity with the regulation cited and the ascertained facts, it would appear that the department should hold that the disability in this case existed prior to enlistment and was therefore not incurred in the line of duty.

No reply was received to the fifth indorsement. This question was constantly becoming more embarrassing. Delay was being caused in the discharge of soldiers on surgeon's certificate of disability owing to different interpretations as to line of duty status by department surgeons and by commanding officers of general hospitals and post surgeons. There was a large volume of correspondence concerning such cases. The subject was therefore again brought to the attention of The Adjutant General in the following communication: [6]

DECEMBER 31, 1919.

From: Commanding officer, United States Army General Hospital No. 43, National Soldiers' Home, Va.

To: Adjutant General of the Army, Washington, D. C.

Subject: Line of duty of mental cases.

1. It is requested that you furnish us a reply to our communication of December 3, 1919, concerning the line of duty of mental cases, a copy of which is inclosed for your convenience.

2. The return of the certificate of disability referred to in paragraph 4 of inclosed communication is desired in order that the soldier may be discharged.

DECEMBER 3, 1919.

From: Chief of neuropsychiatric service, United States Army General Hospital No. 43, National Soldiers' Home, Va.

Through: Commanding Officer, United States Army General Hospital No. 43.

To: Adjutant General of the Army, Washington, D. C.

Subject: Line of duty of mental cases.

1. In view of the decision of the Judge Advocate General, 220.46, February 21, 1919, it has been the policy of this hospital to discharge constitutional psychopaths, mental deficients, and practically all mental diseases in line of duty. I can recall but two exceptions: Psychosis due to venereal disease contracted since the soldier entered the service, and alcoholic psychosis, which are still held to be not in line of duty.

2. We have recently had many inquiries from The Adjutant General's Office requesting explanations as to why soldiers have been discharged in line of duty when the medical history clearly indicated that the mental condition existed prior to enlistment.

3. There has been no difficulty in our establishing the fact that many patients who have been discharged in line of duty had their mental trouble before entering the service, but we assumed that they should all be discharged in line of duty per decision 220.46, J. A. G., but in view of the numerous inquiries from The Adjutant General we believe there must be some conflicting opinion. I feel that it is my duty to bring it to the attention of higher authority that there are now a large number of men who are voluntarily enlisting and concealing the fact that they have been inmates in institutions on account of mental disease, and it is my opinion that the decision of the J. A. G. 220.46 was contemplated to govern drafted men and that G. O. 47, W. D., 1918, should govern in the case of men who voluntarily enlist.

4. I inclose herewith a certificate of disability and correspondence which we have had with the commanding general, Eastern Department, relative to discharging a patient not in line of duty on account of insanity that existed prior to his enlistment, and I request that you advise us in this case in order that we may act intelligently on similar cases in the future.

5. I also inclose correspondence from The Adjutant General's Office concerning another patient whose insanity existed prior to enlistment, but he was discharged in line of duty per decision of the Judge Advocate General, 220.46, February 21, 1919.

[First indorsement]

ADJUTANT GENERAL'S OFFICE,
January 3, 1920.

To the SURGEON GENERAL:
One inclosure.

[Second indorsement]

WAR DEPARTMENT,
SURGEON GENERAL'S OFFICE,
January 16, 1920.

To THE ADJUTANT GENERAL OF THE ARMY:
Returned.

1. Paragraph 448–a, M. M. D., as amended, provides that when the history of a case shows unmistakably that the disability existed prior to entrance into the service, such disability shall be considered as not incurred in line of duty. The Judge Advocate General of the Army has rendered decisions, which have been approved by the Secretary of War, to the effect that under the provisions of section 300 of the war risk insurance act, as amended by section 10 of the act of June 25, 1918, all cases of disability which are found after an officer or enlisted man has been examined, accepted, and enrolled for service must be held to have been incurred in line of duty.

2. In view of the discrepancy thus existing, this office, by thirteenth indorsement, dated March 22, 1919, in the case of W. W., invited attention to this fact and requested instructions as to whether any modification of paragraph 448 of the Manual was necessary. The following reply was received:

[Fifteenth indorsement]

WAR DEPARTMENT,
A. G. O. 201 W. W. (Enl.). ADJUTANT GENERAL'S OFFICE,
May 6, 1919.

To the SURGEON GENERAL OF THE ARMY.

1. Returned. There is no necessity for amending the Manual Medical Department in accordance with section 300 of the war risk insurance act as amended by section 10, Public, 175, Sixty-fifth Congress, provided that the Medical Manual is adhered to in its requirements that full reasons be given by the proper medical officers whenever a decision is reached that a particular disability did not originate in line of duty.

* * * * * * *

3. In view of this decision, it is the opinion of this office that whenever the history of a case shows unmistakably that the disability existed prior to entrance into the service, such disability should be regarded as not incurred in line of duty, unless there is evidence that the disability was aggravated by the military service, in which event the aggravation in disability only should be regarded as incident to the service and as incurred in line of duty. The desirability of such action and reasons therefor have been stated by this office in the thirteenth indorsement referred to above. With the return to voluntary enlistment it becomes increasingly important that the provisions of paragraph 448 be adhered to, since otherwise any physically defective civilian who is able to deceive the recruiting examiner may, after discharge for disability, become a charge upon the Government.

4. It is understood by this office that at some stations the provisions of paragraph 448–a, as amended, are not complied with and that soldiers with disabilities clearly existing prior to entry into the service are certified to be eligible for discharge for conditions "existing prior

to enlistment and in line of duty," this action being based on the decisions of the Judge Advocate General published on pages 263 of Digest for October, 1918, and 94 and 95 of Digest for February, 1919. It is further understood that in many instances, after the discharge has been accomplished, the papers are returned to their point of origin from your office for a statement as to why the soldiers have been discharged in line of duty when the history clearly indicated that the condition leading to discharge existed prior to entry into the service.

5. The approved opinions of the Judge Advocate General of the Army regarding many special cases appear to be in conflict with the decision rendered in the above-mentioned fifteenth indorsement, Adjutant General's Office. Furthermore, the decision contained in the fifteenth indorsement has not been promulgated to the service, in so far as this office is aware. Consequently, great confusion of thought exists among medical officers as to the proper entry regarding line of duty on certificates of disability.

6. It is therefore recommended that the policy of the War Department in regard to such entries as shown in the fifteenth indorsement be published to the service, in order that the medical authorities may no longer be placed in the position of initiating action which is in conflict with fact and manifestly opposed to the interests of the Government.

[Third indorsement]

A. G. 220.811 Enl.

WAR DEPARTMENT,
ADJUTANT GENERAL'S OFFICE,
February 5, 1920.

To the SURGEON GENERAL:

1. Inclosed herewith is advanced copy of Section III, General Orders, No. 7, January 31, 1920.

2. The original communication of December 3, 1919, from commanding officer, United States Army General Hospital No. 43, has been returned to the commanding general, Eastern Department, for compliance with General Orders, No. 7.

By order of the Secretary of War.

The general order referred to in third indorsement is as follows:

General Orders No. 7.

WAR DEPARTMENT,
Washington, January 30, 1920.

* * * * * * *

III. *Determination of line of duty in disability cases.*—In order to secure uniformity and consistency in the findings of medical officers with respect to line-of-duty origin of certain disabilities, the existence of which disabilities prior to entry into service has been established, all concerned in preparing certificates of disability or reports of death will be guided by both Section II, General Orders, No. 47, War Department, 1918, relative to disability existing prior to entry into service and section 300, war risk insurance act, as amended by the act of Congress approved June 25, 1918 (p.10, Bul. No. 41, W. D., 1918), and as further amended by the act of Congress approved December 24, 1919 (p. 4, Bul. No. 1, W. D., 1920), which provides that from April 6, 1917, for the purposes of the war risk insurance act, any person who is examined, accepted, and enrolled for service shall be held to have been in sound condition. The cause of death or origin of disability will be fully set forth, and if death or disability is not due to the person's own misconduct, but, under the provisions of Section II, General Orders, No. 47, can not for other reasons be considered in line of duty, the determination as to line of duty will be stated as follows:

Disability (or death) is regarded as having been incurred in line of duty within the purview of section 300, war risk insurance act, approved October 6, 1917, as amended by act, of Congress approved June 25, 1918, and as further amended by act of Congress approved December 24, 1919, but not in line of duty for other pruposes.

* * * * * * *

By order of the Secretary of War:

(Signed) PEYTON C. MARCH,
General, Chief of Staff.

Official:
P. C. HARRIS,
The Adjutant General.

General Orders, No. 7, definitely settled the question of the determination regarding the line of duty status in any given case and prescribed the notation to be made on certificates of disability and reports of deaths, thereby preventing further complication to that extent. However, this order still left doubt as to the proper entry to be made on sick and wounded register cards (Form 52, M. D.), since they were not mentioned in the order, and presumably must be prepared as required by the Manual for the Medical Department.

Another act of great importance in respect to the disabled entitled to compensation was now enacted. Prior to December 24, 1917, the Director of the Bureau of War Risk Insurance repeatedly held that a drafted man was not in the service of the United States under the provisions of the war risk insurance act until he had been accepted for military service at the mobilization camp to which he had been assigned.[7] In the act of Congress, approved December 2, 1919, amending the war risk insurance act, the following provisions are included:

SEC. 7 That a new section is hereby added to the war risk insurance act, to be known as section 31, and to read as follows:

SEC. 31. That if after induction by the local draft board, but before being accepted and enrolled for active service, the person died or became disabled as a result of disease contracted or injury suffered in the line of duty and not due to his own willful misconduct involving moral turpitude, or as a result of the aggravation, in the line of duty and not because of his own willful misconduct involving moral turpitude of an existing disease or injury, he or those entitled thereto shall receive the benefits of compensation payable under Article III: *Provided,* That any insurance application made by a person after induction by the local draft board, but before being accepted and enrolled for active service, shall be deemed valid.

Under the provisions of this section any man inducted by a local draft board who died or became disabled while en route from the point of induction to a mobilization camp or while at the camp before acceptance was placed under the provisions of the original war risk insurance act with reference to compensation or necessary medical, surgical, and hospital treatment.

SPECIAL CONSIDERATIONS GOVERNING LINE OF DUTY DECISIONS IN PULMONARY TUBERCULOSIS, MENTAL CONDITIONS, AND VENEREAL DISEASE

The general subject of line of duty has now been considered, but it is still necessary to look into this question from the standpoint of certain specific conditions. The three types of disease which have been of special interest in this connection are: Pulmonary tuberculosis, mental conditions, venereal diseases.

PULMONARY TUBERCULOSIS

The question of tuberculosis always has presented numberous difficulties with reference to existence before enlistment. Usually it has proved impossible to give sufficient time to the examination of an individual recruit to permit of a chest examination which, so far as might be, would afford conclusive evidence. At the regular recruit depots, the custom always prevailed of rejecting many men by reason of "poor physique" and in this way many cases of tuberculosis, especially those with moderate involvement, were undoubtedly prevented from entering the Army. With the physical examination under the selective service act, however, such general causes of rejection were not authorized. Therefore, undoubtedly, men frequently were accepted with incipient or slightly developed

pulmonary tuberculosis, or with old inactive lesions. Sooner or later men of the former class came on sick report and the disease was discovered. Naturally the question then arose as to whether the disease existed prior to enlistment or had developed as an incident to the service. As has been previously explained, prior to the World War no hard and fast rules had been laid down for the determination of this question, each medical officer being guided in each case by his own professional judgment after consideration of the history and the results of physical examinations, including X-ray plates. In general it may be said that cases of tuberculosis developing within six months after enlistment usually were condidered as not incurred in line of duty unless the extent of the lesion was so great as to render it morally certain that it had existed for a greater time than the enlistment period. With this method of determination, there were certainly but few cases in which justifiable complaint concerning the findings of medical officers could be made.

However, there were cases in which a soldier, who had apparently recovered from a pulmonary tuberculosis prior to his enlistment, might, after a considerable period of service, again show active evidences of this disease. If the old lesion were considered in such cases, an injustice to the soldier would be done, since such disability should always be considered as in line of duty. Mistakes of this character, though uncommon, had to be carefully guarded against.

With the onset of the World War and the appointment of boards of tuberculosis specialists to examine all members of the Regular Army and of the National Guard then in the service, and to act on all registrants before their induction, it became necessary to have more definite rulings on the subject of tuberculosis than had previously existed. Consequently, on September 11, 1917, the Surgeon General issued the following circular:

Circular No. 24.

WAR DEPARTMENT,
OFFICE OF THE SURGEON GENERAL,
Washington, September 11, 1917.

LINE OF DUTY

The following rules will be observed in determining whether pulmonary tuberculosis has been contracted in the line of duty:

A case of chronic tuberculosis in which the length of service is three months or less shall be considered to be not in line of duty; cases of acute tuberculosis shall be considered to be in line of duty in all cases, irrespective of length of service. When action must be taken in cases in which the distinction between acute and chronic forms is not made, cases of three months' or longer service shall be considered to be not in line of duty unless it be shown that the patient has had some disease since enlistment, such as measles, which may be expected to reactivate tuberculosis, or unless there is a history of excessive fatigue or of exposure in line of duty calculated to break down the resistance of the individual.

(Signed) W. C. GORGAS,
Surgeon General.

Approved by order of the Secretary of War, September 12, 1917. (710, O. D., A. G. O.)

The definite instructions given above materially aided in clarifying the situation, as the question thus was reduced practically to a consideration of the number of months' service. It was, however, constantly the policy of the tuberculosis section of the Surgeon General's Office to give any benefit of doubt to the soldier in questionable cases. The two indorsements next quoted clearly show this:

[First indorsement]

SGO 220.8 (Discharges). War Department,
Surgeon General's Office,
May 13, 1918.

To The Adjutant General of the Army.

* * * * * * *

2. Cases * * * are sometimes met with in which it seems altogether probable that the disability is of long standing, and in such cases the Government appears to suffer injustice. It is, however, better that such rulings should be made because there is a very large number of cases which present some slight evidence of impairment of pulmonary integrity which would be classed as evidence of tuberculosis by many examiners. If such slight signs are admitted as evidence of tuberculosis which existed previous to enlistment, many cases will be diagnosticated as tuberculosis in which the disease is of no clinical importance and large numbers of soldiers are in danger of being discharged for tuberculosis who have not had the disease; or in case some of them later develop tuberculosis which is really incurred in line of duty there is danger that the presence of these old lesions will lead to a decision that the disability was not incurred in line of duty, which would be unjust to the soldier.

3. In view of this state of affairs, it is not expedient that Army medical officers should be permitted to render decision as to the age of the pulmonary lesion if they base their decision solely upon an interpretation of physical signs.

August 2, 1918.

Memorandum for Colonel Van Dusen: [9]

1. The diagnosis in the case of M. D. was acute pulmonary tuberculosis. The requirement of three months' service only applies to chronic pulmonary tuberculosis. According to Circular 24, S. G. O., all cases of acute pulmonary tuberculosis should be considered "in line of duty." This soldier was enlisted as a well man, and the acute exacerbation which Captain Ogden speaks of in the seventh indorsement occurred subsequent to entrance into the service. Who can say that he would have had this exacerbation if he had remained out of the Army and continued a mode of living which was successfully keeping quiescent an old tuberculous focus?

2. It is the opinion of the undersigned that the tuberculous soldier should be given the benefit of the doubt and, unless there is an unmistakable history of pulmonary tuberculosis existing prior to enlistment, his disability be marked in line of duty. It is recommended that the records in the case of M. D. be amended to show that the disability for which he was discharged was incurred in line of duty.

(Signed) E. H. Bruns,
Lieut. Col. Medical Corps, N. A.

The provisions of Circular No. 24 were superseded by Section II, General Orders, No. 47, War Department, 1918, and paragraph 448–a, Manual for the Medical Department, as amended by Changes No. 8 (previously quoted), which continued to be the only regulations of the War Department for the determination of the line of duty status. The decisions and final action regarding these regulations have already been given. Since soldiers discharged from the service subsequent to April 6, 1917, come under the provisions of the war risk insurance act, and this act prescribes that they be considered as having been sound at the time of acceptance, any case of pulmonary tuberculosis (like other cases) is necessarily regarded, for compensation purposes, as incurred in line of duty. Furthermore, subsequent acts have much extended the time after discharge when tuberculosis is assumed to have been contracted in the service.

The reports of the Surgeon General indicate that 3,640 men were discharged from the Army in 1917 by reason of pulmonary tuberculosis, 9,660 in

1918, and 6,439 in 1919.[10] The great majority of the discharges during 1917 were after April 6.[10] This makes a total of 19,739 men separated from the service because of pulmonary tuberculosis during the period under consideration; there still remained, on November 1, 1919, over 3,000 tuberculous patients in Army hospitals,[11] most of whom will eventually be added to the number of discharges.

MENTAL DISEASES

Many of the mental diseases which lead to the discharge of soldiers on certificate of disability belong to a class in which there is an inherently weak nervous system upon which the mental disease is engrafted. A history of this unstable mentality frequently can be elicited. Such men while they remain in civil life are often able to adapt themselves to the existing environment; they can do and act more or less as they please and can change places of occupation and residence when they desire. For these reasons no actual nervous breakdown occurs and the individual, though recognized as peculiar, may not be regarded as actually insane. Put such a man in the military service where he is necessarily governed by strict discipline and the breakdown comes. Doubtless such disabilities should be regarded as incurred in line of duty when it can not be definitely shown that an actual psychosis existed prior to enlistment.

There are other mental and nervous diseases, however, in which the military service could have had no deleterious effect on the individual.

It was the policy of the Surgeon General to be most liberal, under the provisions of the Manual for the Medical Department, with reference to the interpretation of line of duty in mental cases, especially those who had been under any peculiar stress and strain while in the service. The correspondence (sixth indorsement, February 14, 1919) below is an illustration of this fact. With the passage of the war risk insurance act, already mentioned, all mental cases (save those due to misconduct while in the service) were regarded for compensation purposes as in line of duty.

VENEREAL DISEASES

In the third group of cases mentioned above, the venereal diseases, will be found the greatest discrepancy between the pre-war regulations of the War Department and the provisions of the war risk insurance act. Prior to the passage of this act, it had always been customary for medical officers to record all venereal diseases, together with their complications and sequelæ, as not in line of duty, unless they were convinced, in exceptional cases, that the infection was innocent or accidental. Under the provisions of the war risk insurance act the soldier is technically sound when accepted for service and is entitled to compensation and hospital treatment for any disability afterwards detected, unless incurred through his own misconduct. It is believed there has been no decision as to the exact definition of the word "misconduct" in its relation to this law, but decisions rendered by the Judge Advocate General with reference to the term in its bearing on loss of pay when absent from duty for conditions due to misconduct, under the provisions of General Orders, No. 31, 1912, and No. 45, 1914, War Department, have held that exposure to venereal disease

must have occurred after the current enlistment in order to constitute "misconduct." By analogy the same interpretation would hold for the war risk insurance act, and consequently venereal disease contracted before enlistment or induction could not be considered the result of "misconduct" within the meaning of the law.

Shortly after we entered the war, questions began to arise regarding the determination of line of duty in these circumstances, and the following correspondence indicates the position ultimately assumed by the Surgeon General and the action of the War Department thereon. In expressing this opinion the Surgeon General showed much greater liberality than had previously been customary in similar instances.

[Sixth indorsement]

WAR DEPARTMENT,
SURGEON GENERAL'S OFFICE,
February 14, 1919.

TO THE ADJUTANT GENERAL OF THE ARMY:

Returned.

1. Under the provisions of paragraph 448, M. M. D., officers and enlisted men who have been accepted for service at any military station after the first physical examination, "shall be considered to have contracted in the line of duty any subsequently determined physical disability, unless such disability can be shown to be the result of the patient's own carelessness, misconduct, or vicious habits, * * * or unless the history of the case shows unmistakably that the disability existed prior to entrance into the service."

2. There are two classes of cases involved in the determination of "line of duty" status of soldiers recommended for discharge on account of late manifestations of syphilis: First, the class in which the disease has been contracted since entrance into the service. Second, the class in which the disease existed at the time of entrance into the service. The disease in cases of the first class would be held to be the result of the soldier's own "misconduct" and therefore incurred not "in line of duty." The same ruling would ordinarily follow for any subsequently developed disability resulting from the disease. The determination of "line of duty" status in cases of the second class is more difficult. In these cases there is no "misconduct" involved. (Digest, J. A. G., p. 12, Digest of Opinions, J. A. G., April, 1918). Under Special Regulations, 65, War Department, syphilis is no longer a cause for rejection for military service. Many thousands of known syphilitics have been accepted and given active field service during the present war. A certain small percentage of syphilitics will develop insanity (paresis) as a development of the disease, whether in civil life or in the military service. The great majority of syphilitics do not develop the mental disability (paresis). The fact must be recognized, however, that every syphilitic accepted for the military service is a potential paretic. Several cases of insanity (paresis) have been returned from France during the present war, in which the history has shown definite physical and mental stress in combat, and which in the opinion of competent medical officers has been the responsible immediate cause in precipitating the mental breakdown. While the disability (paresis) in these cases is caused by syphilis, it is the opinion of competent psychiatrists that these men might never have suffered a mental breakdown, or at least it might have been delayed for many years, if the soldier had been permitted to remain in his home environment and be spared the stress and hardships of active military service. When it is shown that the insanity (paresis) has been precipitated by the stress or strain of active service, though the remote cause of the disability is known to be syphilis, it is believed that the disability should be held as incurred "in line of duty."

3. No modification or change in existing regulations (par. 448, M. M. D.) appears necessary or desirable. Each case should be determined on its merits, after a careful review of the medical history and consideration of the length and character of service and all other facts pertinent to the case. Under the above interpretation of paragraph 448, M. M. D., there will be a few cases of disability resulting from stress of active service in which the remote

cause was venereal infection, in which the disability will be held to be "in line of duty." In the view of this office, a distinction may be made in these cases between the disability for which the soldier is discharged and the disease causing the disability. A soldier is discharged on account of insanity, the cause of which is syphilis. The soldier probably had the disease when accepted for service, but at that time there was no disability. The Government, in accepting such men for service, under the draft act, should assume the responsibility for any subsequent disability that may develop as a result of military service.

4. The cases of Pvt. G. G. and Wagoner C. A. P., referred to in this correspondence, were recommended for discharge on account of disability "in line of duty," as it was shown clearly in the medical history that stress of active service was responsible for hastening the progress of the disease and causing the mental breakdown. The disease (syphilis) in both cases existed in latent form when the men entered the service, but the disability itself was held to have developed as a result of service and therefore "in line of duty." The case of J. E., 7th Company, Coast Artillery Corps, is not properly comparable with the two cases previously referred to in this paragraph. The medical history in the E. case is not complete, and this office can not express an opinion without further information. If it is shown that the primary infection was contracted since the soldier entered the service, the disease should be held as due to "misconduct" and not "in line of duty." [2]

5. Reference of this paper to the Judge Advocate General of the Army for decision is recommended.

[Seventh indorsement]

201 E. J. Enl.

WAR DEPARTMENT,
ADJUTANT GENERAL'S OFFICE,
February 19, 1919.

To the JUDGE ADVOCATE GENERAL OF THE ARMY:

1. Referred with request for an expression of opinion as to whether or not the disability resulting in the discharge of Pvt. E. should be regarded as having been incurred in line of duty.

By order of the Secretary of War.

[Eighth indorsement]

WAR DEPARTMENT,
JUDGE ADVOCATE GENERAL'S OFFICE,
February 21, 1919.

To THE ADJUTANT GENERAL:

1. The opinion of this office is requested upon the question whether the disability resulting in the discharge of Pvt. J. E. should be regarded as having been incurred in line of duty. It appears that Pvt. E. was accepted for full military service at Fort Slocum, N. Y., December 11, 1914, and performed full military duty up to and including July 26, 1918; that he was discharged January 20, 1919, for disability on account of cerebrospinal syphilis; and that his medical history shows no infection subsequent to enlistment.

2. It is the opinion of this office that the disability resulting in the discharge of Pvt. E. should be regarded as having been incurred in line of duty. He was accepted for full military service and performed full military duty for more than three years. The disease which ultimately caused his disability, if existing at the time of his enlistment, was latent. In the absence of any showing of any misconduct on the part of the enlisted man during the period of his service contributing to cause the disease, the disability must be regarded as having been incurred in line of duty, particularly in view of the provisions of section 300 of the war risk insurane act, as amended by the act of June 25, 1918 (Pub. 175, 65th Cong.), which specifically requires that, for the purposes of compensation under said act, an enlisted man shall be held and taken to have been in sound condition when examined, accepted, and enrolled for service.

[Ninth indorsement]

ADJUTANT GENERAL'S OFFICE,
February 28, 1919.

To the ASSISTANT SECRETARY OF WAR:

Recommending approval of the opinion of the Judge Advocate General of the Army, as set forth in the eighth indorsement.

Steps to obtain a revision of the law in this respect were taken by the War Department in the following letter:

AG 011.3.

WAR DEPARTMENT,
Washington, April 15, 1920.

The honorable the SECRETARY OF THE TREASURY.

SIR: I desire to bring to your attention the desirability of securing an amendment to the first proviso of section 300 of the war risk insurance act (40 Stat. 398, 405), as amended by the act of June 25, 1918 (40 Stat. 609, 611) and by the act of December 24, 1919 (Public No. 104, 66th Cong.), which reads as follows:

Provided, That for the purpose of this section said officer, enlisted man, or other member shall be held and taken to have been in sound condition when examined, accepted, and enrolled for service.

The effect of this proviso is to create a conclusive presumption of soundness when men are accepted for service. Yet, as more fully appears from extracts from a memorandum submitted by the Surgeon General and which are inclosed, it frequently happens that diseases or defects which are actually existent at the time of acceptance can not be detected by means of such a medical examination as is possible at the time, but when later discovered can be clearly shown to have existed prior to acceptance.

It may be that during the emergency, when men were drafted into the service, such an attitude on the part of the Government toward them as is manifested in this proviso may have been justified, but, as appears from the extracts from the Surgeon General's report, to which reference has aready been made, it has been the cause of the loss of millions of dollars to the Government, and the policy thus enunciated should not be continued now that voluntary enlistments have been resumed; also, the tendency will be to encourage the enlistment of men with latent diseases or defects, thus shifting of the burden of their care to the Federal Government, where it does not properly belong.

There ought not, it seems to me, to be any objection to creating in favor of the men accepted for service that presumption of soundness which naturally arises from the fact of acceptance, but this presumption, instead of being conclusive should be rebuttable, should be overcome by a determination, carefully made and sustained by clear and convincing proof, that the disability was incurred prior to acceptance for service.

I am transmitting this letter to you and also to the Secretary of the Treasury because I feel that if those departments which are concerned with this matter are in accord as to their views respecting it, remedial legislation should speedily be requested of Congress. I submit for your consideration the following amendment, which it is believed will protect the interests of the men accepted for service and at the same time safeguard the interests of the Government.

A BILL To amend section 300 of the war risk insurance act, as amended by the act of June 25, 1918, and by the act of December 24, 1919

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the first proviso of section 300 of the war risk insurance act, as amended by the act of June 25, 1918, and by the act of December 24, 1919, be amended to read as follows: *Provided*, That for the purpose of this section said officer, enlisted man, or other member shall be presumed to have been in sound condition when examined, accepted, and enrolled for service but that such presumption may be overcome when, under such regulations as may be prescribed by the Secretary of War, the Secretary of the Navy, or the Secretary of the Treasury, depending on the service into which the officer, enlisted man, or other member has been accepted, it is shown by clear and convincing proof that the disability found to exist subsequent to acceptance for service nevertheless existed prior to acceptance: *Provided further*, That if it be as shown that the disability existed prior to acceptance for

service, but there is reason to believe that it has been aggravated by his service, then compensation shall be payable under the provisions of this act only to the extent that the disability has been aggravated: *And provided further,* That no rights which have already accrued shall be affected by this amendment.

Respectfully,

NEWTON D. BAKER,
Secretary of War.

REFERENCES

(1) Sixth indorsement, War Department, J. A. G. O., April 1, 1919, to The Adjutant General. On file, Record Room, Correspondence File, J. A. G. O., 220.46, and A. G. O., 201 (Kilpatrick, Edgar M.).

(2) Eleventh indorsement, War Department, J. A. G. O., March 6, 1919, to The Adjutant General. On file, Record Room, Correspondence File, J. A. G. O., 220.46, and A. G. O. 201 (Haley, Bud).

(3) Fourth indorsement, War Department, J. A. G. O., March 18, 1919, to The Adjutant General. On file, Record Room, Correspondence File, J. A. G. O., 220.46, and A. G. O. 201 (Beckley, Allen L.).

(4) Letter from The Adjutant General to the commanding general, Camp Jackson, S. C., dated December 20, 1918, on case of William Walker, with fifteenth indorsement, War Department, A. G. O., May 6, 1919, to the Surgeon General. On file, Record Room, S. G. O., Correspondence File, 201 (Walker, William).

(5) Letter from The Adjutant General to the Surgeon General of the Army, dated September 20, 1919, on Disability for Discharge (approved by Secretary of War, October 20, 1919), with indorsements. On file, Record Room, S. G. O., Correspondence File, 201 (Russo, Angeo).

(6) Letter from the commanding officer, United States Army General Hospital No. 43, National Soldiers' Home, Va., to The Adjutant General, December 31, 1919, re line of duty of mental cases, with copies of inclosures. On file, Record Room, A. G. O., Correspondence File, 220.811 (Misc. Div.).

(7) Decisions of acting general counsel for Bureau of War Risk Insurance, July 2, 1919. On file, Library of War Veterans' Bureau.

(8) First indorsement, War Department, S. G. O., May 13, 1918, to The Adjutant General of the Army. On file, Record Room, S. G. O., Correspondence File, 220.9 (Discharge).

(9) Memorandum for Col. Van Dusen, August 2, 1918, from Lieut. Col. Bruns. On file, Record Room, S. G. O., Correspondence File, 201 (Duggan, Michael).

(10) Annual reports of the Surgeon General, United States Army, 1918, 560; 1919, Vol. I., CCLVIII; 1920, 682.

(11) Based on sick and wounded reports made to the Surgeon General.

56706—28——39

INDEX

Page

Accuracy of the brine flotation-loop method for the detection of ova of intestinal parasites 539
Acute gonorrhea:
complications of 282
treatment 278
Acute posterior urethritis, treatment 281
Acute prostatitis, complication of acute gonorrhea 283
Acute seminal vesiculitis, complication of acute gonorrhea 283
Acute urethritis, severe, treatment 279
Adenitis, suppurative inguinal, in chancroidal infections 291
Admission and death rates during the World War, malarial fevers 512
Admission to hospital for disease, relative importance of typhoid fever as a cause of, and of deaths from disease 24
Age:
effect of, on the incidence and mortality of respiratory diseases 90
neurocirculatory asthenia and 561
Albuminuria, temporary, from arsphenamin in the treatment of syphilis 302
Allied armies and in the military forces of Germany and Austro-Hungary, smallpox in 369
American Expeditionary Forces:
occurrence in the, of—
diphtheria 242
German measles 470
measles 425
mumps 456
scarlet fever 399
syphilis 295
tuberculosis 185
venereal diseases 269
American Third Army in Germany, typhoid fever in the 35
Ankylostomiasis (*see also*, Hookworm disease) 529
Anopheles, species of, concerned in the transmission of malaria in camps in the United States 523
Anopheline mosquitoes, length of flight of 524
Anthrax 223–232
complications and concurrent diseases 228
diagnosis 228
eliology 224
pathology 225
prognosis 229
prophylactic measures 229
statistical considerations 223
symptoms 227
treatment 230
Anterior urethritis:
chronic, in chronic gonorrhea 284
subacute, treatment 280
Armies:
occurrence of Vincent's disease in 494
of seven of the nations participating in the World War, occurrence of typhoid fever in the 38
Army:
Austrian, typhoid fever in 42
Belgian, typhoid fever in 41
British, typhoid fever in 40
distribution in the, of malarial fevers 513
French, typhoid fever in 40
German, typhoid fever in 42
Italians, typhoid fever in 41

Army—Continued.
occurrence in the, of— Page
trench fever 485
smallpox, prior to the World War 358
typhoid fever during the World War 21
preventive measures inaugurated in the, during the World War 42
United States—
comparison of death rates from typhoid fever in the, and in the civil population 20
comparison of malarial rates for the World War with previous and subsequent malarial rates 511
occurrence of Vincent's disease in 494
typhoid fever in 39
typhoid fever in the, prior to the World War, and as compared with World War incidence 16
Army and civil death rates for inflammatory diseases of the respiratory tract 86
Army in the United States:
occurrence in the, of—
German measles 465
scarlet fever 396
syphilis 294
venereal disease 269
Arsphenamine:
in the treatment of syphilis 300
reactions from, in the treatment of syphilis 301
technique of administration 305
Arterial tension in neurocirculatory asthenia 573
Association of malarial fevers with other diseases 525
Asthenia, neurocirculatory. (*See*, Neurocirculatory asthenia.)
Austrian Army, typhoid fever in 42
Austro-Hungarian Army, smallpox in the 371
Austro-Hungary and Germany, allied armies and, smallpox in the 369
Autopsy findings in the dysenteries 344
Bacteriology of complications of measles 436
Belgian Army, typhoid fever in 41
Blood, the, in neurocirculatory asthenia 571
Blood pressure in neurocirculatory asthenia 571
Brine flotation-loop method for the detection of ova of intestinal parasites 532
accuracy of 539
modifications of 538
technique 533
British Army:
smallpox in 369
typhoid fever in 40
Bronchitis, influenza, broncho-pneumonia, lobar pneumonia, inflammatory diseases of the respiratory tract 61
Broncho-pneumonia, lobar pneumonia, bronchitis, influence, inflammatory diseases of the respiratory tract 61
Camp:
Beauregard, La., cerebrospinal meningitis at 213
Bowie, Tex., smallpox at 364
Cody Replacement Company, Company No. 4, typhoid fever in 30
Devens, Mass., smallpox at 365
Dodge, Iowa, smallpox at 365
Funston, Kans.—
cerebrospinal meningitis at 213
smallpox at 365
Jackson, S. C., cerebrospinal meningitis at 213
Pike, Ark., smallpox at 365
Taylor, Ky., smallpox at 365
Wadsworth, S. C., cerebrospinal meningitis at 213
Camps, in the United States:
distribution of malarial fevers in white and colored enlisted men, by 515
occurrence by, of—
diphtheria 238
measles 415
tuberculosis 182
species of anopheles concerned in the transmission of malaria in 523
Cardiac disturbances in neurocirculatory asthenia 572
Care of patient while taking mercury for syphilis 309
"Carrier", the, malarial fevers 525

Page
Carriers:
diphtheria 252
technique of examination for 256
treatment of 259
dysenteries 341
typhoid 52
Cases of typhoid fever, total number of 22
Cause of admission to hospital for disease and of deaths from disease, relative importance of typhoid fever as a 24
Centers, hospital. (*See* Hospital centers.)
Cerebrospinal meningitis 203–221
at Camp—
Beauregard, La 213
Funston, Kans 213
Jackson, S. C 213
Wadsworth, S. C 213
complications, sequelæ, and concurrent diseases 217
diagnosis 215
distribution by grades 206
etiology 214
geographical distribution—
in Europe 213
in the United States 206
prevention 218
racial distribution 206
statistical considerations 204
treatment 215
Chancre, treatment of the 300
Chancroidal infections 287
complications, sequelæ, and concurrent diseases 289
diagnosis 287
prognosis 289
suppurative inguinal adenitis in 291
treatment 289
Chicken-pox 387–390
complications and sequelæ 389
diagnosis 389
prognosis 390
statistical considerations 387
symptoms 388
treatment 390
Chordee, complication of acute gonorrhea 282
Chronic anterior urethritis in chronic gonorrhea 284
Chronic gonorrhea 284
Chronic posterior urethritis, in chronic gonorrhea 285
Chronic prostatitis, in chronic gonorrhea 285
Chronic seminal vesiculitis, in chronic gonorrhea 286
Civil death rates for inflammatory diseases of the respiratory tract, comparison of Army and 86
Civil population:
comparison of death rates from typhoid fever in the United States Army and in the 20
occurrence of Vincent's disease in the 494
Climate and weather, effect of, on incidence and mortality of the respiratory diseases 107
Clinical aspects, certain, inflammatory diseases of the respiratory tract 154
Clinical course of typhoid fever in the vaccinated individual 50
Colitis, enteritis, and nonspecific diarrhea 352
Colored and white enlisted men, by camps, in the United States, distribution of malarial fevers in 515
Command, measures designed to prevent the entrance and spread in a, of infection by inflammatory diseases of the respiratory tract 116
Company No. 4, Camp Cody Replacement Company, typhoid fever in 30
Comparison:
of Army and civil death rates for inflammatory diseases of the respiratory tract 86
of death rates from typhoid fever in the United States Army and in the civil population 20
of malarial rates for the World War with previous and subsequent malarial rates, United States Army 511

Page
Complications:
and concurrent diseases, anthrax 228
of acute gonorrhea 282
of measles, bacteriology of 436
Complications and sequelæ:
chicken pox 389
German measles 471
inflammatory diseases of the respiratory tract 160
mumps 460
scarlet fever 403
smallpox 384
trench fever 489
typhoid fever, and concurrent diseases 51
Complications, sequelæ, and concurrent diseases:
cerebrospinal meningitis 217
chancroidal infections 289
diphtheria 245
gonococcus infection 274
measles 431
syphilis 298
Concurrent diseases and complications, anthrax 228
Concurrent diseases, complications and sequelæ:
cerebrospinal meningitis 217
chancroidal infections 289
diphtheria 245
gonococcus infection 274
measles 431
syphilis 298
typhoid fever 51
"Conscientious" and other "objectors," malingering, and cowardice, relation of occurrence of neurocirculatory asthenia to 564
Control and preventive measures, diphtheria 248
Countries where our troops served, others, smallpox in 369
Course:
and prognosis, encephalitis lethargica 478
clinical, of typhoid fever in the vaccinated individual 50
of cases, estimating, in treatment with mercury 309
Cowardice, malingering, "conscientious," and other "objectors," relation of occurrence of neurocirculatory asthenia to 564
Cubicle, use of, to prevent entrance and spread in a command of inflammatory diseases of the respiratory tract 122
Curel, France, typhoid fever in Medical Department Units at 33
Death and admission rates during the World War, malarial fevers 512
Death rate from typhoid fever 25
Death rates:
for inflammatory diseases of the respiratory tract, comparison of Army and civil 86
for typhoid fever in the United States Army and in the civil population, comparison of 20
Deaths from disease, relative importance of typhoid fever as a cause of admission to hospital for disease, and of 24
Decisions:
as to whether or not disabilities were in line of duty 587–609
laws, and regulations governing the line of duty decision 587
line of duty, in pulmonary tuberculosis, mental conditions, and veneral disease, special considerations governing 602
Dermatitis and erythema in the treatment of syphilis with arsphenamine 303
Detection of ova of intestinal parasites, methods used for the 531
Determination of line of duty, tuberculosis 198
Diagnosis:
anthrax 228
cerebrospinal meningitis 215
chancroidal infections 287
chicken pox 389
diphtheria 246
dysenteries 345
encephalitis lethargica 479
German measles 471
gonococcus infection 274
malarial fevers 526
measles 438

Diagnosis—Continued. Page
mumps 458
neurocirculatory asthenia 580
scabies 555
scarlet fever 405
smallpox 383
syphilis 295
trench fever 490
tuberculosis 190
typhoid fever 54
Vincent's disease 501
Diarrhea, nonspecific, enteritis and colitis 352
Diarrheal group of diseases 311–356
occurrence in the World War 322
Digestive symptoms of neurocirculatory asthenia 576
Diphtheria 233–261
carriers 252
treatment of 259
complications, sequelæ and concurrent diseases 245
control and preventive measures 248
diagnosis 246
occurrence—
in the American Expeditionary Forces 242
in the United States 237
pathology 244
statistical considerations 233
symptoms 244
technique of examination for carriers 256
treatment 250
wound 259
Disabilities, decisions as to whether or not, were in line of duty 587
Disability:
discharge on account of, from typhoid fever 26
discharges for, resulting from vaccination for smallpox 380
Discharge on account of disability from typhoid fever 26
Discharges for disability resulting from vaccination for smallpox 380
Disease, relative importance of typhoid fever as a cause of admission to hospital for, and of deaths from 24
Disease processes, other, relation of neurocirculatory asthenia to 570
Diseases:
inflammatory, of the respiratory tract (bronchitis, influenza, broncho-pneumonia, lobar pneumonia) 61
of the skin 551–557
respiratory, factors tending to modify the incidence and mortality of the 90
Distribution:
and prevalence of the dysenteries 331
by grade (commissioned and enlisted personnel), of typhoid fever 25
by grades, cerebrospinal meningitis 206
by States, malarial fevers 516
geographic—
of cerebrospinal meningitis 206
of hookworm infection in the United States 540
of neurocirculatory asthenia 563
of smallpox 363
of typhoid fever 26
of malarial fevers—
in the Army 513
in white troops in the United States, Panama, Philippine Islands, and Hawaiian Islands 514
racial—
of cerebrospinal meningitis 206
of malarial fevers 513
of smallpox 371
of typhoid fever 25
seasonal, of typhoid fever 26
Division:
77th, typhoid fever in 31
79th, typhoid fever in 31
88th, typhoid fever in the 33
Duty, line of. (*See*, Line of duty.)

Page
Dysenteries:
autopsy findings in the 344
carriers 341
diagnosis 345
etiologic types 327
etiology 336
incidence by months 334
occurrence 326
prevalence and distribution 331
preventive measures 350
prognosis 344
symptomatology and pathology 343
the 326
treatment 347
Efficiency, relative, of prophylactic measures, malarial fevers 521
Eighty-eighth Division, typhoid fever in the 33
Electrocardiography in neurocirculatory asthenia 571
Encephalitis:
hemorrhagic, in the treatment of syphilis with arsphenamine 303
lethargica 473–481
course and prognosis 478
diagnosis 479
etiology 474
pathology 476
preventive measures and treatment 480
symptoms 477
Endocrine symptoms in neurocirculatory asthenia 575
Enlisted men, white and colored, distribution of malarial fevers in, by camps, in the United States 515
Enteritis, colitis, and nonspecific diarrhea 352
Entrance and spread of infection, by inflammatory diseases of the respiratory tract, in a command, measures designed to prevent 116
Epidemiology:
of German measles 470
of inflammatory diseases of the respiratory tract 63
of tuberculosis 186
Epididymitis, complication of acute gonorrhea 282
Erythema and dermatitis, in treatment of syphilis with arsphenamine 303
Etiologic types of the dysenteries 327
Etiology:
and transmission, trench fever 485
of anthrax 224
of cerebrospinal meningitis 214
of encephalitis lethargica 474
of inflammatory diseases of the respiratory tract 143
of malarial fevers 523
of neurocirculatory asthenia 565
of smallpox 381
of the dysenteries 336
of Vincent's disease 497
Europe, cerebrospinal miningitis in 213
Europe (Russia excepted), typhoid fever in 28
Evacuation of infected individuals, malarial fevers 522
Examination for carriers, diphtheria, technique of 256
Factors:
influencing—
infection, venereal diseases 270
occurrence, measles 427
occurrence of mumps 456
occurrence of scarlet fever 400
tending to modify the incidence and mortality of the respiratory diseases 90
that may be responsible for the occurrence of typhoid in individuals presumably protected by vaccination 47
Fatigue, undue, protection of troops from, to prevent entrance and spread in a command, of inflammatory diseases of the respiratory tract 121
Febrile reaction from arsphenamine in the treatment of syphilis 302
Fever, scarlet. (*See* Scarlet fever.)
Fever, trench. (*See* Trench fever.)
Fever, typhus. (*See* Typhus fever.)

Fevers:
Page
paratyphoid ... 57
the malarial ... 511–527
typhoid and paratyphoid ... 15
Flight of anopheline mosquitoes, length of ... 524
Flotation-loop, brine, method. (*See* Brine flotation-loop method.)
Fluoroscopic findings in neurocirculatory asthenia ... 574
Folliculitis, complication of acute gonorrhea ... 282
French Army:
smallpox in ... 369
typhoid fever in ... 40
Gastric test meal in neurocirculatory asthenia ... 571
Gatherings, public, limitation of, to prevent entrance and spread in a command of inflammatory diseases of the respiratory tract ... 122
General measures for prevention of smallpox ... 380
Geographic distribution:
of cerebrospinal meningitis ... 206
of hookworm infection in the United States ... 540
of neurocirculatory asthenia ... 563
of smallpox ... 363
of typhoid fever ... 26
German Army:
smallpox in the ... 371
typhoid fever in ... 42
German measles ... 463–472
complications and sequelæ ... 471
diagnosis ... 471
epidemiology ... 470
occurrence—
in the American Expeditionary Forces ... 470
in the United States ... 465
prognosis ... 470
prophylactic measures ... 472
statistical considerations ... 463
symptoms ... 470
treatment ... 472
Germany:
and Austro-Hungary, Allied armies and, smallpox in the ... 369
typhoid fever in the American Third Army in ... 35
Glandular urethritis, in chronic gonorrhea ... 284
Gonococcus infection ... 271
complications, sequelæ, and concurrent diseases ... 274
diagnosis ... 274
occurrence by months ... 273
prognosis ... 276
treatment ... 278
Gonorrhea:
acute—
complications of ... 278
treatment ... 278
chronic ... 284
Grade (commissioned and enlisted personnel), distribution of typhoid fever by ... 25
Grades, distribution by, cerebrospinal meningitis ... 206
Hawaii, typhoid fever in ... 26
Hawaiian Islands, Philippine Islands, Panama, United States, distribution of malarial fevers in white troops in ... 514
Health, general lowering of, in treatment of syphilis with arsphenamine ... 302
Helminth infections in overseas and home-service troops ... 546
Hemorrhagic encephalitis in the treatment of syphilis with arsphenamine ... 303
Heredity, neurocirculatory asthenia and ... 563
Herxheimer reaction in the treatment of syphilis with arsphenamine ... 304
Hookworm (*see also*, Ankylostomiasis) infection in the United States, geographical distribution of ... 540
Hospital centers, occurrence in, in the American Expeditionary Forces, of diphtheria ... 244
Housing conditions, effect of, on incidence and mortality of respiratory diseases ... 110
Immunity and susceptibility, inflammatory diseases of the respiratory tract ... 126
Importance and prevalence of inflammatory diseases of the respiratory tract during the war period ... 65

Page
Incidence:
and mortality of the respiratory diseases, factors tending to modify 90
by months, dysenteries 334
of typhoid fever in the United States Army prior to the World War, and as compared with World War 16
Infected individuals, malarial fevers, evacuation of 522
Infection:
by inflammatory diseases of the respiratory tract, measures designed to prevent the entrance and spread of, in a command 116
factors influencing, venereal diseases 270
gonococcus 271
chancroidal 287
Infectious jaundice, typhus fever, trench fever 483–493
Inflammatory diseases of the respiratory tract (bronchitis, influenza, broncho-pneumonia, lobar pneumonia) 61–169
certain clinical aspects 154
comparison of Army and civil death rates 86
complications and sequelæ 160
epidemiology 63
etiology 143
influenzal cycle during the war period 130
measures designed to prevent the entrance and spread of infection in a command 116
mode of transmission 111
pathology 145
roentgenology 152
prevalence and importance during the war period 65
prevention 115
susceptibility and immunity 126
treatment 163
pneumonia 164
Influence of occupation on occurrence of neurocirculatory asthenia 563
Influenza:
bronchitis, broncho-pneumonia, lobar pneumonia, inflammatory diseases of the respiratory tract 61
treatment 163
Influenzal cycle of inflammatory diseases of the respiratory tract during the war period 130
Inguinal adenitis, suppurative, in chancroidal infections 291
Injections:
in treatment of syphilis, technique of 308
mercury, in the treatment of syphilis 307
Inspection, medical, to prevent the entrance and spread in a command of infection by inflammatory diseases of the respiratory tract 118
Intestinal parasites 529–549
in certain of the overseas and home-service troops 543
methods used for the detection of ova of 531
Inunctions, mercury, in treatment of syphilis 307
Italian Army:
smallpox in 370
typhoid fever in 41
Jaundice:
infectious. *See* Infectious jaundice.
in the treatment of syphilis with arsphenamine 303
Laboratory findings in neurocirculatory asthenia 571
Late syphilis 310
Laws, regulations, and decisions governing the line of duty decision 587
Length of flight of anopheline mosquitoes 524
Length of service:
effect of, on the incidence and mortality of respiratory diseases 90
relationship of smallpox to, and to previous vaccination 372
Limitation of public gatherings to prevent entrance and spread in a command of inflammatory diseases of the respiratory tract 122
Line of duty:
decisions—
as to whether or not disabilities were in 587
in pulmonary tuberculosis, mental conditions, and venereal disease, special considerations governing 602
determination of in tuberculosis 198
Line of duty decision, laws, regulations, and decisions governing the 587
Lipovaccine, typhoid 44

Page
Lobar pneumonia, bronchitis, influenza, broncho-pneumonia, inflammatory diseases of the respiratory tract 61
Malaria in camps in the United States, species of anopheles concerned in the transmission of 523
Malaria plasmodia, the species of 523
Malarial fevers, the 511–527
admission and death rates during the World War 512
association with other diseases 525
diagnosis 526
distribution—
by States 516
in the Army 513
in white and colored enlisted men, by camps, in the United States 515
in white troops in the United States, Panama, Philippine Islands, and Hawaiian Islands 514
etiology 523
mortality 520
pathology 526
present status of prophylactic measures 521
preventive measures 520
racial distribution 513
relative efficiency of prophylactic measures 521
seasonal prevalence 519
symptomatology 525
the "carrier" 525
treatment 526
Malarial rates, comparison of, for the World War with previous and subsequent malarial rates, United States Army 511
Malingering, "conscientious," and other "objectors," and cowardice, relation of occurrence of neurocirculatory asthenia to 564
Management and treatment of tuberculosis 195
Marseille, typhoid fever in Motor Reception Park at 34
Mask, use of the, to prevent the entrance and spread in a command, of infection by inflammatory diseases of the respiratory tract 118
Meal, gastric test, in neurocirculatory asthenia 571
Medical inspection, to prevent the entrance and spread in a command of infection by inflammatory diseases of the respiratory tract 118
Measles 409–450
bacteriology of complications 436
complications, sequelæ, and concurrent diseases 431
diagnosis 438
factors influencing occurrence 427
German. (*See* German measles.)
occurrence—
by camps 415
in the American Expeditionary Forces 425
in the civil population 422
in the United States 414
preventive measures 440
prognosis 439
relation of occurrence to mobilization 414
statistical considerations 409
during the World War 411
prior to the World War 409
symptoms 429
treatment 447
Measures designed to prevent the entrance and spread of infection, by inflammatory diseases of the respiratory tract, in a command 116
Medical Department units at Curel, France 33
Meningitis, cerebrospinal. *See* Cerebrospinal meningitis.
Mental and nervous symptoms of neurocirculatory asthenia 578
Mental conditions, pulmonary tuberculosis, and venereal disease, special considerations governing line of duty decisions in 602, 605
Mercury:
care of patient while taking 309
injections in treatment of syphilis 307
in the treatment of syphilis 307
inunctions, in the treatment of syphilis 307

Page
Method, brine flotation-loop, for the detection of ova of intestinal parasites 532
Methods used for the detection of ova of intestinal parasites 531
Minor outbreaks of typhoid fever 35
Mobilization, relation of occurrence of measles to 414
Mode of transmission of inflammatory diseases of the respiratory tract 111
Modifications of brine flotation-loop method for the detection of ova of intestinal parasites 538
Monovalent saline vaccine, typhoid 43
Months:
incidence by, of dysenteries 334
occurrence by, of gonococcus infection 273
Mortality:
of malarial fevers 520
of the respiratory diseases, factors tending to modify the incidence and 90
of tuberculosis 198
Mosquito nets, in prevention of malarial fevers 522
Mosquitos, anopheline, length of flight of 524
Motor Reception Park, Marseille, typhoid fever in 34
Mumps 451–462
complications and sequelæ 460
diagnosis 458
factors influencing occurrence 456
occurrence—
in the American Expeditionary Forces 456
in the United States 453
pathology 458
preventive measures 461
statistical considerations 451
symptoms 457
treatment 459
Nativity, State of, effect of, on respiratory diseases 97
Nausea from arsphenamin in the treatment of syphilis 301
Neoarsphenamine, technique of administration 306
Nephritis, in the treatment of syphilis with arsphenamine 303
Nerve involvement, recurrences of, the treatment of syphilis with arsphenamine 304
Nervous and mental symptoms of neurocirculatory asthenia 578
Neurocirculatory asthenia 559–586
age and 561
arterial tension in 573
cardiac disturbances in 572
diagnosis 580
digestive symptoms of 576
endocrine symptoms in 575
etiology 564
fluoroscopic findings in 574
geographical distribution 563
heredity and 563
influence of occupation on occurrence 563
laboratory findings in 571
nervous and mental symptoms of 578
neurovascular disturbances in 574
occurrence in the World War 561
pathology 569
pre-war occurrence 559
prognosis 580
race and 562
relation of occurrence to malingering, "conscientious," and other "objectors," and to cowardice 564
relation to other disease processes 570
respiratory symptoms in 577
sex and 562
sex characteristics in 576
symptoms and signs 572
the physical type 569
treatment 581
Neurovascular disturbances in neurocirculatory asthenia 574
Noneffective rates for typhoid fever 26
Nonspecific diarrhea, enteritis and colitis 352
Number, total, of cases of typhoid fever 22

Page
"Objectors," "conscientious" and other, cowardice, and malingering, relation of occurrence of neurocirculatory asthenia to 564
Occupation, influence of, on occurrence of neurocirculatory asthenia 563
Occurrence:
of diphtheria—
in the American Expeditionary Forces 242
in the United States 237
of German measles—
in the American Expeditionary Forces 470
in the United States 465
of gonococcus infection, by months 273
of measles—
by camps 415
factors influencing 427
in the American Expeditionary Forces 425
in the civil population 422
in the United States 414
relation of, to mobilization 414
in the American Expeditionary Forces 456
in the United States 453
of mumps—
factors influencing 456
of neurocirculatory asthenia—
in the World War 561
influence of occupation on 563
relation of, to malingering, "conscientious," and other "objectors," and to cowardice 564
of scarlet fever—
factors influencing 400
in the American Expeditionary Forces 399
in the Army in the United States 396
of smallpox—
during the World War 362
in the Army prior to the World War 358
of syphilis—
in other countries 295
in the American Expeditionary Forces 295
in the Army in the United States 294
of the diarrheal group of diseases in the World War 322
of trench fever in the Army 458
of typhoid fever—
in the armies of seven of the nations participating in the World War 38
in the Army during the World War 21
in individuals presumably protected by vaccination, factors that may be responsible for 47
of the dysenteries 326
of tuberculosis 182
of venereal diseases—
in other countries 270
in the American Expeditionary forces 269
in the United States 269
of Vincent's disease—
in armies 494
in civil population 494
in the United States Army 494
pre-war, of neurocirculatory asthenia 559
Organization for eliminating the tuberculous from the Army 171
Outbreaks, minor, of typhoid fever 35
Ova of intestinal parasites, methods used for the detection of 531
Panama, Philippine Islands, Hawaiian Islands, and the United States, distribution of malarial fevers in white troops in 514
Parasites, intestinal. (*See* Intestinal parasites.)
Paratyphoid:
A and B saline vaccines (1916–17) 43
and typhoid fevers 15
in the 77th Division 31
fevers 57

Page
Pathology:
and symptomatology, of the dysenteries 343
of anthrax 225
of diphtheria 244
of encephalitis lethargica 476
of inflammatory diseases of the respiratory tract 145
of malarial fevers 526
of mumps 458
of neurocirculatory asthenia 569
of scarlet fever 401
of trench fever 490
Personnel (commissioned and enlisted), distribution of typhoid fever by grade 25
Philippine Islands:
Hawaiian Islands, United States, and Panama, distribution of malarial fevers in white troops in 514
smallpox in the 369
Physical type, the, in neurocirculatory asthenia 569
Plasmodia, malaria, the species of 523
Pneumonia, treatment 164
Population, civil:
comparison of death rates from typhoid fever in the United States Army and in the 20
occurrence of Vincent's disease in the 494
Posterior urethritis:
acute, treatment 281
chronic, in chronic gonorrhea 285
subacute, treatment 281
Preparation and care of patient in treatment of syphilis with arsphenamine 301
Present status of prophylactic measures, malarial fevers 521
Prevalence:
and distribution of the dysenteries 331
and importance during the war period, of inflammatory diseases of the respiratory tract 65
seasonal, of malarial fevers 519
Prevention:
of cerebrospinal meningitis 218
of inflammatory diseases of the respiratory tract 115
Preventive measures:
and control, diphtheria 248
and treatment, encephlalitis lethargica 480
dysenteries 350
for smallpox 373
inaugurated in the Army during the World War 42
for malarial fevers 520
for measles 440
mumps 461
scarlet fever 406
trench fever 491
Vincent's disease 507
Prognosis:
anthrax 229
chancroidal infections 289
chicken-pox 390
course and, of encephalitis lethargia 478
German measles 470
gonococcus infection 276
measles 439
neurocirculatory asthenia 580
scarlet fever 406
syphilis 299
Vincent's disease 507
Prophylactic measures:
anthrax 229
German measles 472
relative efficiency of, malarial fevers 521
present status of, malarial fevers 521
Prophylactic sprays, use of, to prevent the entrance and spread in a command, of inflammatory diseases of the respiratory tract 120
Prophylactic vaccination:
local and systemic reaction following 45
to prevent entrance and spread in a command of inflammatory diseases of the respiratory tract 124

Page
Prophylaxis, quinine, in malarial fevers 522
Prostatitis, acute complication of acute gonorrhea 283
Prostatis, chronic gonorrhea 285
Protection of troops from undue fatigue, to prevent the entrance and spread in a command, of inflammatory diseases of the respiratory tract 120
Public gatherings, limitation of, to prevent entrance and spread in a command of inflammatory diseases of the respiratory tract 122
Quarantine, to prevent the entrance and spread in a command of infection by inflammatory diseases of the respiratory tract 116
Quinine prophylaxis, malarial fevers 522
Race:
and neurocirculatory asthenia 562
effect of, on the incidence and mortality of the respiratory diseases 94
Racial distribution:
American troops (white and colored), smallpox 371
of cerebrospinal meningitis 206
of malarial fevers 513
of typhoid fever 25
Rate, death, from typhoid fever 25
Rates:
admission and death, during the World War, malarial fevers 512
death—
for inflammatory diseases of the respiratory tract, comparison of Army and civil 86
typhoid fever in the United States Army and in the civil population, comparison of 20
malarial, comparison of, for the World War with previous and subsequent malarial rates, United States Army 511
noneffective, for typhoid fever 26
Reaction:
early, in the treatment of syphilis with arsphenamine 301
febrile, from albuminuria in treatment of syphilis with arsphenamine 302
Herxheimer, in the treatment of syphilis with arsphenamine 304
immediate acute, from albuminuria in the treatment of syphilitis with arsphenamine 302
local and systemic, following prophylactic vaccination 45
Reactions:
from arsphenamine in the treatment of syphilis 301
early 301
late 302
Recurrences of new involvment in the treatment of syphilis with arsphenamine 304
Regulations, laws, and decisions governing the line of duty decision 587
Relation:
of neurocirculatory asthenia to other disease processes 570
of occurrence—
of measles to mobilization 414
of neurocirculatory asthenia to malingering, "conscientious," and other "objectors," and to cowardice 564
Relationship of smallpox to length of service and to previous vaccination 372
Relative efficiency of prophylactic measures, malarial fevers 521
Replacement Company, Company No. 4, Camp Cody, typhoid fever in 30
Respiratory diseases. (*See also*, Inflammatory diseases of the respiratory tract.)
factors tending to modify the incidence and mortality of the—
age 90
climate and weather 107
housing conditions 110
length of service 90
race 94
State of nativity 97
Respiratory symptoms, in neurocirculatory asthenia 577
Respiratory tract, inflammatory diseases of the (bronchitis, influenza, bronchopneumonia, lobar pneumonia) 61
Roentgenology, inflammatory diseases of the respiratory tract 152
Saline triple typhoid vaccine 44
Salivation from mercury in the treatment of syphilis 309
Scabies 553
diagnosis 555
treatment 556

	Page
Scarlet fever	391–408
complications and sequelæ	403
diagnosis	405
Scarlet fever:	
occurrence—	
factors influencing	400
in the American Expeditionary Forces	399
in the Army in the United States	396
pathology	401
preventive measures	406
prognosis	406
statistical considerations	391
symptoms	401
treatment	407
Seasonal distribution of typhoid fever	26
Seasonal prevalence, malarial fevers	519
Seminal vesiculitis:	
acute, complication of acute gonorrhea	283
chronic, in chronic gonorrhea	286
Sequelæ:	
and complications—	
of chicken pox	389
of German measles	471
of inflammatory diseases of the respiratory tract	160
of mumps	460
of scarlet fever	403
of smallpox	384
of trench fever	489
of typhoid fever, and concurrent diseases	51
complications, and concurrent diseases—	
of cerebrospinal meningitis	217
of chancroidal infections	289
of diphtheria	245
of gonococcus infection	274
of measles	431
of syphilis	298
Service, length of:	
effect of, on the incidence and mortality of respiratory diseases	90
relationship of smallpox to, and to previous vaccination	372
Seventy-seventh Division, typhoid and paratyphoid fevers in	31
Seventy-ninth Division, typhoid fever in	32
Sex, neurocirculatory asthenia and	562
Sex characteristics in neurocirculatory asthenia	576
Signs and symptoms, neurocirculatory asthenia	572
Skin, diseases of the	551–557
Smallpox	357–386
complications and sequelæ	384
diagnosis	383
discharges for disability resulting from vaccination	380
etiology	381
general measures for prevention of	380
geographical distribution	363
in Europe (Russia excepted)	368
in other countries where our troops served	369
in the allied armies and in the military forces of Germany and Austro-Hungary	369
in the Austro-Hungarian Army	371
in the Belgian Army	370
in the British Army	369
in the French Army	369
in the German Army	371
in the Italian Army	370
in the Philippine Islands	369
in the United States	363
occurrence—	
during the World War	362
in the Army prior to the World War	358
preventive measures for	373
racial distribution, American troops (white and colored)	371
relationship of, to length of service and to previous vaccination	372
symptoms	381
vaccination for prevention of	373

Page
Special considerations governing line of duty decisions in pulmonary tuberculosis, mental conditions, and venereal disease 602
Species:
of anopheles concerned in the transmission of malaria in camps in the United States 523
of malaria plasmodia 523
Sprays, prophylactic, use of, to prevent the entrance and spread in a command of inflammatory diseases of the respiratory tract 120
Spread, entrance and, of infection by inflammatory diseases of the respiratory tract, in a command, measures designed to prevent 116
State of nativity, effect of, on the incidence and mortality of the respiratory diseases 97
States, distribution of malarial fevers by 516
Statistical considerations:
anthrax 223
cerebrospinal meningitis 204
chicken pox 387
diphtheria 233
German measles 463
measles 409
mumps 451
scarlet fever 391
venereal diseases 263
Subacute anterior urethritis, treatment 280
Subacute posterior urethritis, treatment 281
Suppurative inguinal adenitis, in chancroidal infections 291
Susceptibility and immunity, inflammatory diseases of the respiratory tract 126
Symptomatology:
and pathology, dysenteries 343
malarial fevers 525
Symptoms:
and signs, neurocirculatory asthenia 572
anthrax 227
chicken pox 388
digestive, of neurocirculatory asthenia 576
diphtheria 244
encephalitis lethargica 477
endocrine, in neurocirculatory asthenia 575
German measles 470
measles 429
mumps 457
nervous and mental, of neurocirculatory asthenia 578
respiratory in neurocirculatory asthenia 577
scarlet fever 401
smallpox 381
trench fever 488
Vincent's disease 500
Syphilis 292
complications, sequelæ, and concurrent diseases 298
diagnosis 295
late 310
occurrence—
in other countries 295
in the American Expeditionary Forces 295
in the Army in the United States 294
prognosis 299
treatment 300
of the chancre 300
systemic 300
with arsphenamine 300
with mercury 307
with neoarsphenamine 306
Technique:
of arsphenamine administration 305
of examination for carriers, diphtheria 256
of injections of mercury in the treatment of syphilis 308
of neoarsphenamine administration 306
Test meal, gastric, in neurocirculatory asthenia 571
Third Army, American, in Germany, typhoid fever in 35
Total number of cases of typhoid fever 22

Page
Transmission:
and etiology, trench fever 485
mode of, of inflammatory diseases of the respiratory tract 111
of malaria in camps in the United States, species of anopheles concerned in the 523
Treatment:
and management of tuberculosis 195
and preventive measures, encephalitis lethargica 480
of acute gonorrhea 278
of acute posterior urethritis 281
of anthrax 230
of cerebrospinal meningitis 215
of chancroidal infections 289
of chicken pox 390
of diphtheria 250
of the dysenteries 347
of German measles 472
of gonococcus infection 278
of inflammatory diseases of the respiratory tract 163
of influenza 163
of malarial fevers 526
of measles 447
of mumps 459
of neurocirculatory asthenia 581
of carriers, diphtheria 259
of pneumonia 164
of scabies 556
of scarlet fever 407
of severe acute urethritis 279
of subacute anterior urethritis 280
of subacute posterior urethritis 281
of syphilis 300
of trench fever 492
of Vincent's disease 507
Trench fever 483, 485
complications and sequelæ 489
diagnosis 490
etiology and transmission 485
occurrence in the Army 485
pathology 490
preventive measures 491
symptoms 488
treatment 492
Triple typhoid vaccine, saline 44
Troops:
overseas and home-service—
helminth infections in 546
intestinal parasites in certain of the 543
protection of, from undue fatigue, to prevent entrance and spread in a command of inflammatory diseases of the respiratory tract 120
white, in the United States, Panama, Philippine Islands, and Hawaiian Islands, distribution of malarial fevers in 514
Tuberculosis 171–202
determination of line of duty 198
diagnosis 190
epidemiology 186
management and treatment 195
mortality 198
occurrence 182
in camps in the United States 182
in the American Expeditionary Forces 185
organization for eliminating the tuberculous from the Army 171
pulmonary, mental conditions, and venereal disease, special considerations governing line of duty decisions in 602
Tuberculous, the, organization for eliminating, from the Army 171
Types, etiologic, of the dysenteries 327
Typhoid and paratyphoid fevers 15–60
in the 77th Division 31
Typhoid carriers 52

Page
Typhoid fever:
complications, sequelæ, and intercurrent diseases 51
death rate from 25
diagnosis 54
discharge on account of diability from 26
distribution by grade (commissioned and enlisted personnel) 25
factors that may be responsible for the occurrence of, in individuals presumably protected by vaccination 47
geographical distribution of 26
in Company No. 4, Camp Cody Replacement Company 30
In Europe (Russia excepted) 28
in Hawaii 26
in Medical Department units at Curel, France 33
in the American Third Army in Germany 35
in the Austrian Army 42
in the Belgian Army 41
in the British Army 40
in the 88th Division 33
in the French Army 40
in the German Army 42
in the Italian Army 41
in the Motor Reception Park, Marseille 34
in the 79th Division 32
in the United States 35
in the United States Army 39
and in the civil population, comparison of death rates from 20
prior to the World War, and as compared with World War incidence 16
in the vaccinated individual, clinical course of 50
introduction of use of vaccines (1908–16) 43
minor outbreaks of 35
noneffective rates for 26
occurrence of—
in the armies of seven of the nations participating in the World War 38
in the Army during the World War 21
preventive measures inaugurated in the Army during the World War 42
racial distribution of 25
relative importance of, as a cause of admission to hospital for disease and of deaths from disease 24
seasonal distribution of 26
total number of cases of 22
Typhoid vaccine, triple, saline 44
Typhoid vaccines, period of the World War (1917–18) 44
Typhus fever 483
United States:
distribution of malarial fevers in white and colored enlisted men, by camps, in the 515
geographical distribution—
of cerebrospinal meningitis in the 206
of hookworm infection in the 540
occurrence in the—
of diphtheria 237
of mumps 453
of measles in the 414
occurrence in the Army in the—
of German measles 465
of scarlet fever 396
of syphilis 294
of venereal diseases 269
Panama, Philippine Islands, and Hawaiian Islands, distribution of malarial fevers in white troops in the 514
smallpox in the 363
species of anopheles concerned in the transmission of malaria in camps in the 523
typhoid fever in the 35
United States Army, occurrence of Vincent's disease in 494
Units, Medical Department, at Curel, France, typhoid fever in 33

	Page
Urethritis:	
acute posterior, treatment	281
chronic anterior, in chronic gonorrhea	284
chronic posterior, in chronic gonorrhea	285
glandular, in chronic gonorrhea	284
severe acute, treatment	279
subacute anterior, treatment	280
subacute posterior, treatment	281
Urine, the, in neurocirculatory asthenia	571
Vaccinated individual, clinical course of typhoid fever in the	50
Vaccination:	
factors that may be responsible for the occurrence of typhoid in individuals presumably protected by	47
for prevention of smallpox	373
smallpox, discharges for disability resulting from	380
previous, relationship of smallpox to length of service and to	372
prophylactic—	
local and systemic reaction following	45
to prevent entrance and spread in a command of inflammatory diseases of the respiratory tract	124
Vaccine:	
monovalent saline, typhoid	43
saline triple typhoid	44
Vaccines:	
introduction of use of (1908–16)	43
paratyphoid A and B saline (1916–17)	43
typhoid, period of the World War (1917–18)	44
Venereal disease, pulmonary tuberculosis, and mental conditions, special considerations governing line of duty decisions on	602, 605
Venereal diseases	263–310
factors influencing infection	270
gonococcus infection	271
occurrence—	
in other countries	270
in the American Expeditionary Forces	269
in the United States	269
statistical considerations	263
Vesiculitis:	
acute seminal, complication of acute gonorrhea	283
chronic seminal, in chronic gonorrhea	286
Vincent's disease	493–509
diagnosis	501
etiology	497
occurrence—	
in armies	494
in civil population	494
in the United States Army	494
preventive measures	507
prognosis	507
symptoms	500
treatment	507
Weather and climate, effect of, on incidence and mortality of the respiratory diseases	107
White and colored enlisted men, by camps, in the United States, distribution of malarial fevers in	515
White troops in the United States, Panama, Philippine Islands, and Hawaiian Islands, distribution of malarial fevers in	514
Wound diphtheria	259

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